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MANHATTAN ELEVATED RAILWAY EXTENSIONS are recommended by the special contract committee of the Rapid Transit Board. The franchises recommended practically include all that the Manhattan Co. has asked for, and they are as follows: Two additional tracks from City Hall and along the Bowery to 5th St.; a continuous third track on Third Avenue, from 5th to 129th St.; the northern extension of the east side line to Bedford Park; a continuous third track on the 9th and 8th Avenue line, from Rector to 155th St.; the construction of the West St. and ferry connecting line; a City Hall cross town branch along Centre and Canal Sts. to West St.; and a line beginning at 9th Avenue and 53d St., and passing out 10th or Amsterdam Avenue to Kings Bridge. Battery Park is preserved intact, and in each case rentals, time of completion and penalties are fixed. The rentals range from 5% on gross receipts, to 2% of the increase on gross receipts at certain designated stations. The Kings Bridge line would have an increasing rental from 1% of gross receipts of extended line for the first year to 5% after the fourth year.

THE BRENNAN EAST RIVER BRIDGE BILL passed the New York Assembly on March 22. This calls for the construction of a new East River suspension bridge for railways, bicyclers and foot-passengers. The Mayor of New York is to appoint a commission of six citizens, who will have charge of the construction. The bridge would start in Brooklyn somewhere between the Navy Yard and Fulton St., and end in New York between Houston St. and the present East River Bridge.

THE RENEWAL OF A BRIDGE carrying the Chicago & Northwestern Ry. over the Chicago River at Kinzie St. was carried out on March 13. The old 184-ft. draw span was removed and towed away, and a new 200-ft. draw span (with pivot located eccentrically, under one of the chords), was floated into place and deposited on the pier, which had been rebuilt. New abutments had also been built. Scows loaded with water ballast were placed under the ends of the bridge, and when the blocking was adjusted the water was pumped out, the buoyancy of the scows then raising the bridge from its seat. It was then towed clear of the site, being held by guy lines from hoisting engines on the shore. The new bridge had been erected on launching ways about 100 ft. from the old bridge, and after one end had been supported on scows the other end was allowed to slide down the ways until it reached other scows. When properly afloat it was towed into position, and deposited by admitting water ballast into the scows. The total time occupied was 24 hours, and during this time all trains stopped at and started from a temporary station in the yards west of the river. The new bridge weighs about 365 tons and was built by the Lassig Bridge & Iron Works, of Chicago. It was designed by Mr. W. H. Finley, Bridge Engineer of the C. & N. W. Ry., who also planned the operations for the work of renewal.

THE CHICAGO DRAINAGE CANAL will be completed in about fifteen months, and Chief Engineer Randolph submitted the following estimate of work still to be done:

Tail race at Lockport	$90,000
Tail race to upper basin	150,000
Construction and right of way, Joliet	1,760,000
Movable railway and highway bridges	1,153,724
Chicago River improvement	386,000
Total	$3,539,724

PART OF THE STATE CANAL SYSTEM OF OHIO is to be sold if bills now before the legislature of that state become laws. These bills appoint a commission of disinterested members which is to examine the property and appraise its value, as a roadbed for steam or electric railways, and for its value to abutting owners, with and without the railways. It is then to be advertised and sold on 15 years' purchase at 6%, or on a 99-year lease. If not sold or leased, the stone in the locks can be sold and the water turned into the nearest stream, and the property turned over as a public highway. The reasons given for this action are that the canals are obsolete and serve no public purpose, except to provide salaries for a number of officials. The portion to be first disposed of in this way is that part of the Ohio Canal lying south of Millersport, in Fairfield Co., to Portsmouth, and including the Columbus Feeder, running from Columbus to Lockbourne. The southern division of the Ohio Canal now costs about $45,000 per year to keep in repair, and the annual receipts are less than $10,000.

BROOKLYN DRY-DOCK No. 3, so long under repair, is now being tested. There is some leakage about the steps for the caisson gate; but this may be ascribed to the hardening of the rubber packing at this point, or to some twist in the caisson itself, which was under a heavy strain during the repairs. But the leaks found are not important, and Naval Constructor Bowles hopes to have the coffer-dam removed and the dock ready for service by May 1.

THE TWIN-SCREW STEEL STEAM YACHT "MAYflower," bought by the government from the Goelet estate for conversion into a torpedo-boat destroyer, was built at Clydebank, England, from the designs of G. W. Watson, and she was launched in 1896. The "Mayflower" is 321 ft. long over all, 36 ft. 6 ins. beam, 16 ft. 8 ins. draft, and has a displacement of 2,400 tons. She is brigantine rigged and fitted with powerful triple-expansion engines giving a speed of over 20 knots. She has a coal-carrying capacity of 700 tons. She is so strongly built that few alterations will be required for her new service. Mounts for 6-in. rapid-fire guns will be placed upon her, and her armament will also include torpedo-tubes and a number of smaller rapid-fire guns.

THE CHIEFS OF THE BUREAU OF YARDS AND Docks of the Navy Department, and the predecessors of Mr. M. T. Endicott, C. E., U. S. N., just appointed to that office, were as follows: 1842 to 1846, Commodore Lewis Warrington; 1846 to 1869, Commodore Joseph Smith; 1869 to 1871, Captain Daniel Ammen; 1871 to 1874, Commodore C. R. P. Rodgers; 1874 to 1878, Commodore John C. Howell; 1878 to 1881, Captain Richard L. Low; 1881 to 1885, Rear-Admiral E. T. Nichols; 1885 to 1889, Captain D. B. Harmony; 1889 to 1890, Captain George B. White; 1890 to 1894, Captain Norman N. Farquhar; 1894 to 1897, Commodore E. O. Matthews. As seen above the Bureau has heretofore never had a Chief below the rank of Captain, and the fact that the relative rank of Mr. Endicott was that of Commander, was at first used against him. But, fortunately for the country, fitness for the position wins against mere rank. While in this office Mr. Endicott will have the relative rank of Commodore.

BRITISH SHIPPING, says Lloyds, now aggregate a gross tonnage of over 13,000,000. In 1897 the tonnage of steamers increased by 159,057 tons, and that of the sailing fleet decreased by 150,430 tons. On Jan. 1, 1898, the official register showed 8,590 steamers, aggregating 10,396,760 tons, and 11,916 sailing vessels with a tonnage of 2,758,866 tons. The United States holds second place in the merchant shipping of the world, with 4,769,000 tons. Germany has 1,000,000 tons, and the tonnage of France is under 1,000,000.

THE CUNARD STEAMSHIP "LUCANIA" arrived at Queenstown, on March 18, with a new record of an hourly average across the Atlantic of 22.92 knots. Her best day's run was 530 and 531 knots, beating her best previous eastward daily run of 526 knots. Going westward, however, the "Lucania" has made 562 knots in one day. The "Campania" and "Kaiser Wilhelm der Grosse" have both made 528 knots per day going eastward.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred, March 15, on the Pennsylvania Short Line at New Boston, Pa. At this point the tracks cross a 40-ft. ravine on a wooden bridge, which collapsed as a freight train was crossing. The engine passed safely, but the remainder of the train crashed through the middle span. Nine men were carried down, three of whom are reported seriously injured.

THE FERRY-HOUSE of the Pennsylvania R. R. at Jersey City, N. J., was injured to the extent of $100,000, on March 21, as the result of a fire, which, it is believed, originated in the restaurant of the station. Passengers were greatly inconvenienced, but no serious accidents resulted.

A MINE EXPLOSION in the Santa Isabel Mine, at Belmez, Province of Cordova, Spain, is reported. The account further states that 70 bodies have been recovered and many men are unaccounted for.

A SERIOUS FIRE IN CHICAGO, in the heart of the city, occurred March 16, resulting in the loss of at least seven lives, and injuries to a large number of persons, while about 20 more are missing and supposed to be buried in the ruins. The Ayer Building, on Wabash Ave., between Adams St. and Jackson Boulevard, caught fire about 11 a. m., and the flames spread with such rapidity that in ten minutes it was a blazing furnace, and in twenty minutes the roof and floors had fallen in, while the front and back walls fell very soon after, leaving nothing but a pile of wreckage on the ground. The building was an old one, seven stories high, with iron front and columns, the floors carried by pine girders resting on brackets on the columns. The Building Department claims that the girders were not properly anchored to the columns and walls, thus accounting for the rapid collapse of the building, but the architect denies this, and the wreck is so complete that the exact facts will probably never be known. There was only one fire escape, an 18-in. vertical iron ladder, which became red hot, and many persons were injured in jumping from the windows. The building was occupied by wall paper and music dealers and by a photographic company which had a large quantity of chemicals, the explosion of which spread the flames, and an air shaft carried the flames from floor to floor. The two elevator boys ran their cars until the machinery refused to work. The ties of the elevated loop railway caught fire, but the flames were extinguished before any great damage was done, and after the building had fallen, traffic was resumed, flagmen being placed at short intervals, on account of the dense smoke. The disaster has aroused some agitation over the powerful opposition made by owners of buildings to the law requiring the use of fire escapes on buildings of this sort, and it may also result in some check upon the storage of dangerous materials in large quantities in the office building district.

THE NEW JERSEY GRADE CROSSING BILL, submitted by Senator Johnson, has been signed by the Governor, and is now a law. The bill provides that whenever the governing body of any city, town, township, borough, village or other municipality in the State, shall deem it necessary that gates, or flagmen shall be provided at any railway crossing, it may petition the Court of Chancery for such order as the Court shall deem necessary. The Court shall notify the railway company and investigate the case; and if the Court shall deem the request reasonable and necessary, it shall issue a decree to that effect, which the railway company shall comply with within a reasonable time. If the railway company applies for the crossing, the Court will decide what part, if any, of the expense of establishing gates and maintaining flagmen shall be borne by the municipality. This law does not apply to the towns of Essex and Hudson Counties, as they already have power to compel the protection of grade crossings without the intervention of the courts.

CHICAGO POLICEMEN AS GUARDS AT RAILWAY crossings in that city, are to be removed by order of Mayor Harrison. This releases about 200 policemen, and hereafter the railway companies will have to furnish and pay these guards, at a cost of about $240,000 a year, in the aggregate. The custom of using city police for this service is a very old one, though threats to remove them have been made before.

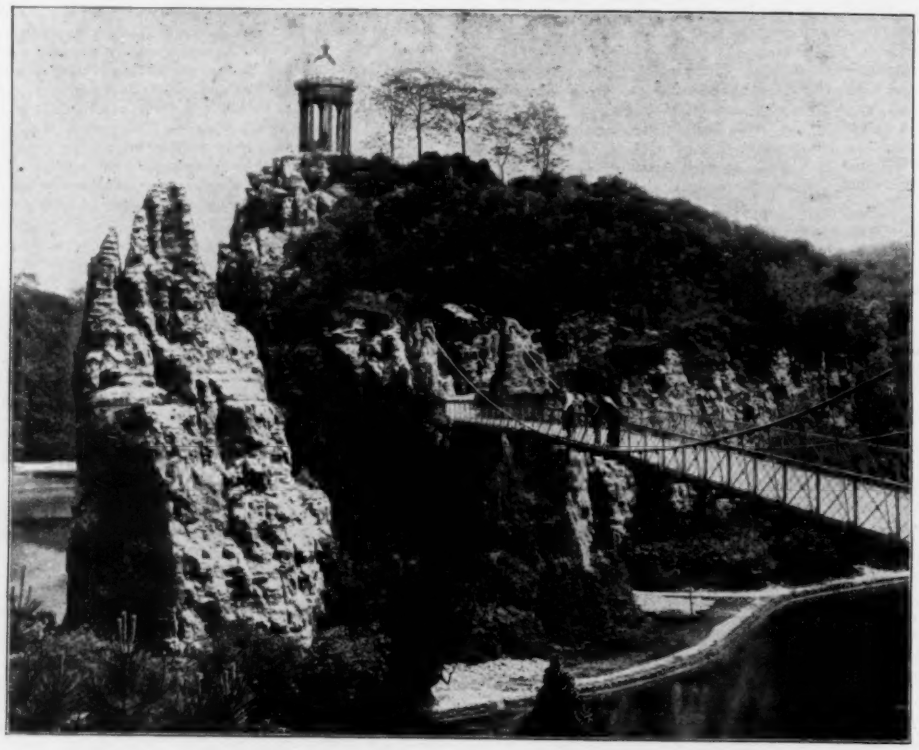
THE ELECTRIC STORAGE BATTERY CO., of Philadelphia, in its annual report, states that for the year ending Dec. 31, 1897, the sales amounted to $1,026,925, against $572,281 for 1896, or an increase of $454,644. The net profits for 1897 were $340,008, and for 1896, $148,799 showing an increase of $191,209.

10,000 HP. WILL BE TRANSMITTED 110 MILES to San Francisco if the plans of a company, of which Prince Poniatowsky is said to be the head, are completed. It is proposed to utilize the water now running to waste on the western slope of the Sierra Nevada Mountains in Alpine, Amader and Calveras counties, constructing a system of canals and a power plant. The transmission line at one place will cross San Francisco Bay with a span about 325 ft. above the water. The total cost of the plant is estimated at about $1,000,000.

A SUSPENSION BRIDGE WITH NATURAL ROCK PIERS; PARC DES BUTTES CHAUMONT, PARIS.

We are indebted to Prof. J. L. Van Ornum, Assoc. M. Am. Soc. C. E., who is traveling in Europe, for the view of the suspension bridge in the Parc des Buttes Chaumont, in Paris, which we reproduce herewith. It is an interesting example of the manner in which Continental engineers endeavor to harmonize their works with the surroundings.

The park in which this structure is located is situated in the northeastern part of Paris in the quarter chiefly occupied by the artisan class. It



A SUSPENSION BRIDGE WITH NATURAL ROCK PIERS; PARC DES BUTTES CHAUMONT, PARIS.

has been lately laid out, and substitutes for a notorious haunt of criminals a place of recreation for working people. The island crowned by the small Corinthian temple is about in the center of the park, and the bridge gives pedestrians access to this island from one side. The photograph, however, really gives this bridge more prominence than it actually possesses.

The bridge itself is of the usual suspension type, 200-ft. span, with three wire cables, each 6¾ ins. diameter, on each side. There is an iron stiffening truss of 36 panels, 3½ ft. deep; and the roadway is 10 ft. wide and about 40 ft. above the water of the lake beneath. The particularly interesting and only novel feature is in the abutment piers supporting the cables. These piers are limestone rock in place; formed by blasting away all superfluous parts. They are irregular, pyramidal frustrums; about 17 ft. high and about 3 ft. square at the top and 20 ft. by 6 to 8 ft. at the bottom. The cables are led through ducts cut in the tops and then securely anchored in the native rock behind them.

EXPERIMENTS UPON WATER RAM.

Some tests of the effect of suddenly stopping the flow of water in a closed pipe system were recently made at the Thayer School of Civil Engineering of Dartmouth College, Hanover, N. H., and were described in a graduating thesis by Mr. Samuel A. McCoy, of Independence, Mo., and Mr. Henry N. Chase, of Harwich, Mass. As a result of the experiments the following practical conclusions were reached respecting water ram in pipe systems:

1. The force of the ram varies directly as the velocity of the water flowing in the pipe system.

2. The force of the ram varies directly as the speed of closing the valve or gate.

3. The force of the ram varies directly as the volume of water flowing in the pipe system.

4. In a simple open system the pressure in pounds per sq. in. due to water ram = $Wr \div a\ g\ t$.

5. Dead ends in the vicinity of the point of discharge greatly increase the ram.

6. In a large closed system the pressure follows the line of least resistance and does not give as high values as theory requires.

7. With screw valves, as large rams are as liable to occur from closing fractional as from the closing of full openings of the valve. It is the actual stoppage of the flow that causes the ram. While the valve is closing the increase in pressure due to checking the velocity is very small.

8. The use of quarter-turn quick closing valves on any pipe system should be prohibited.

9. The present practice of allowing 100 lbs. in estimating the thickness of metal of pipe errs on the safe side, provided slow-motion screw valves are used.

10. In designing a water-supply system, the pipes should form a closed circuit, thus doing away with the excessive pressure caused by the use of dead ends.

11. Relief valves should be introduced into all systems where the static pressure is above 100 lbs.

BEAR TRAP DAM FOR REGULATING WORKS, CHICAGO DRAINAGE CANAL.*

(With two-page plate.)

I.

Introduction.

The regulating works for the Chicago Drainage Canal constitute one of the most elaborate constructions for controlling the flow of large volumes of water which the history of hydraulic engineering exhibits. This canal is constructed to carry a volume of 600,000 cu. ft. of water per minute, and the smallest permissible flow will be 300,000 cu. ft. per minute. It is to preserve and control this flow of water that the regulating works are being built. Briefly described, they comprise, first, 15 sluice gates, 30 ft. wide by 20 ft. high, which work up and down between masonry piers; and, second, a bear trap dam with a clear opening of 160 ft. The dam will be recognized at once as the largest structure of its type in the world. For its size alone it is worthy of mention, but, as those familiar with the problems of such structures will recognize, this fact of magnitude involves questions of construction and operation which overshadow the mere dimensional importance of the structure.

In Engineering News of Nov. 21 and Dec. 12, 1895, detailed illustrations and a full description of the sluice gates for the Drainage Canal regulating works were published, and to this and a succeeding issue the great bear trap dam will be described in equal detail. As far as possible the descriptive matter and the drawings have been made to supplement each other; that is all repetition of information given in the one has been avoided as much as possible in the other. To this fact the attention of the reader is called particularly, for upon its recognition depends his thorough understanding of the work and its problems.

Conditions of the Problem.

To comprehend clearly the significance of the particular designs and constructions adopted for the regulating works it is necessary to consider briefly the controlling conditions of flow and discharge of water through the channel, and this necessitates a repetition at times of information already published in Engineering News*. Such repetition has been cut down as much as possible.

Conditions of Flow and Discharge.—The location of the Drainage Canal in relation to the Des Plaines River and the adjacent country was shown by the large map published in Engineering News of May 16, 1895. It will be remembered that the main channel between Summit and Lockport, Ill., was designed for a flow of 600,000 cu. ft. per minute; and between Chicago and Summit for a flow of 300,000 cu. ft. per minute. The intention is that 300,000 cu. ft. per minute shall be the flow through the whole channel at as early a date as possible, and that later the prism between Chicago and Summit shall be enlarged and the flow be increased to 600,000 cu. ft. per minute as rapidly as finances and the necessities of the case will permit. The maximum flow in the Des Plaines River westward from Summit at the present time, it is estimated, will be 400,000 cu. ft. per minute, and when the entire flow of the river is diverted westward its maximum magnitude will be between 800,000 and 900,000 cu. ft. per minute. It is to be noted that at the present time the flood waters of the Des Plaines are divided a little north of Summit and just south of Riverside, at the spillway (Eng. News, June 27, 1895), a part of them flowing eastward to the west fork of the Chicago River and just north of the main channel.

Fig. 1 is a profile or combination of profiles, showing the elevation of the bottom of the main channel of the Des Plaines River and of the tail race. These are all shown in full lines. The location of the regulating works is shown both on the map and by Fig. 1, and is at the south end of the main channel and north end of the tail race. The Des Plaines River joins the tail race near its head immediately south of the end of the main channel, at which point the elevation of the bottom of tail race is (—18) C. D. (Chicago Datum). The elevation of the bottom of the tail race between the regulating works and the junction with the Des Plaines River is —15.0 C. D. The profile shows the comparatively steep slope of the Des Plaines valley below Lockport. The purpose of the tail race is to carry the combined flow of the main channel and the river down the steep slope, a result that can be accomplished better in a wide and shallow channel than in one deep and narrow. The main channel, being across a flat country, could be better designed to have a deep and narrow channel. From the nature of the case the latter must terminate somewhere and the former originate at the same place. With reference to economy in construction this place was determined to be at or near the place occupied by the regulating works. To reach this place it was necessary to construct the lower end of the

* For the benefit of those who may desire to study the latest available literature treating upon bear trap dam theory and practice the following references are given: For complete mathematical analyses of the White, Parker and Marshall bear traps and for a valuable consideration of the general subject and of several special structures of this class see the "Journal of the Association of Engineering Societies," June, 1896. In the Transactions of the American Society of Civil Engineers for March, 1898, Mr. B. F. Thomas gives a valuable historical review of Movable Dams, tracing their development and illustrating and describing most of the important types which have been used in Europe and in the United States. Other valuable historical records and technical discussions will be found in: Annual Reports of the Chief of Engineers, U. S. A., for 1884, 1887 and other years; Trans. Am. Soc. C. E., for 1882; Engineering News, Oct. 18, 1890, and Feb. 7 and March 21, 1895, and various histories of Pennsylvania, where the development of the Lehigh Coal & Navigation Co. is described.

* In 1895, Engineering News published a series of 22 illustrated articles descriptive of the Chicago Drainage Canal. These articles have been revised and added to and published in book form by the Engineering News Publishing Co.

main channel partly in excavation and partly in embankment. This construction, it will be seen, had the effect of raising the elevation of the bed of the tail race to near the surface of the ground. This, in turn, permitted the tail race to be constructed partly in excavation and partly in embankment, the material excavated being about sufficient for the embankment. The elevation given to the bed of the tail race was made as high as possible, and yet not be too high to prevent at any time the necessary flow from the main channel. After much study and many estimates it was discovered that a width of 400 ft. for the tail race and an elevation as shown on the profiles lead to the least cost for construction. Thus dimensioned the depth of flow in the tail race above its junction with the Des Plaines is estimated to be about 7½ ft. and below its junction with the river about 10 ft.

The arrangement adopted leads to two extreme conditions of elevation of water surface in the several channels considered. One corresponds to a condition of minimum flow and the other to a condition of maximum flow. These water surfaces must be observed with some attention to avoid confusion, for the conditions are peculiar and involve at least one anomaly.

Minimum flow will occur when there is no flow through the main channel and when the Des Plaines is dry, at which time there will be no flow in the tail race. Remember now that high water in Lake Michigan is +5.0 C. D., and let the water surface be determined for such an occasion. There will be no water in the river or tail race, but in the main channel water will stand with its surface at the level indicated by a dotted line on Fig. 1. It will be noted that high water in the main channel corresponds to a condition of no flow, which is just the reverse of what happens in natural streams and is therefore anomalous.

Maximum flow will occur when the main channel is carrying all the water its declivity will permit and when the Des Plaines River is in flood, at which time the tail race will be flowing its maximum volume. Let the water level of Lake Michigan, for this occasion, be low or at elevation 0.0 C. D. Then the conditions of water surface in the main channel, Des Plaines River and tail race, will be as indicated by the broken line on Fig 1. In this profile it will be noted that low water in the main channel corresponds to a state of maximum flow while the reverse is the case for the river and tail race. It will also be noted that a fall of water surface of 2 ft. is shown to take place in the Chicago River. This is explained by the fact that plans for a flow from Lake Michigan to the main channel have not yet been determined, and in advance of such determination the main channel has been designed on the hypothesis that whatever connecting channel may be constructed the loss of head in it will be 2 ft. when the conditions of maximum flow occur at a time when the level of Lake Michigan is at 0.0 C. D.

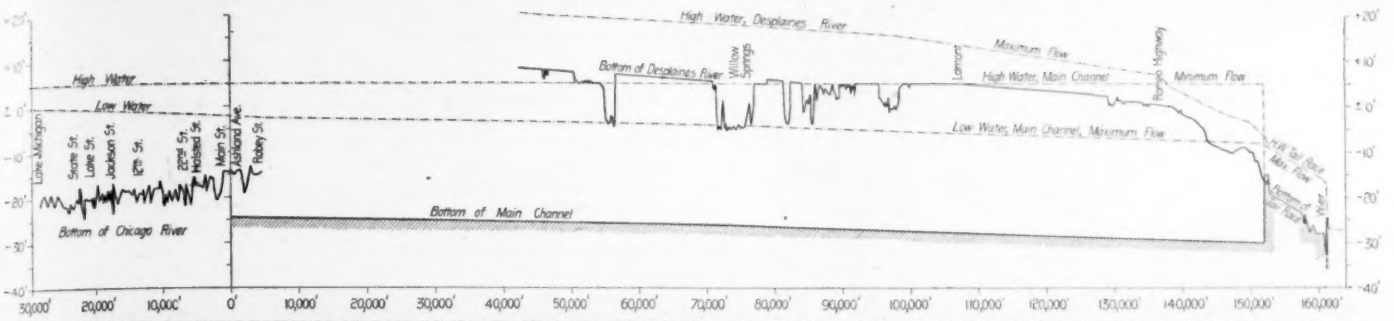


FIG. 1.—PROFILE SHOWING BOTTOMS OF MAIN DRAINAGE CHANNEL, DESPLAINES RIVER, TAIL RACE, AND THE WATER SURFACES FOR MAXIMUM AND MINIMUM FLOW IN THOSE CHANNELS.

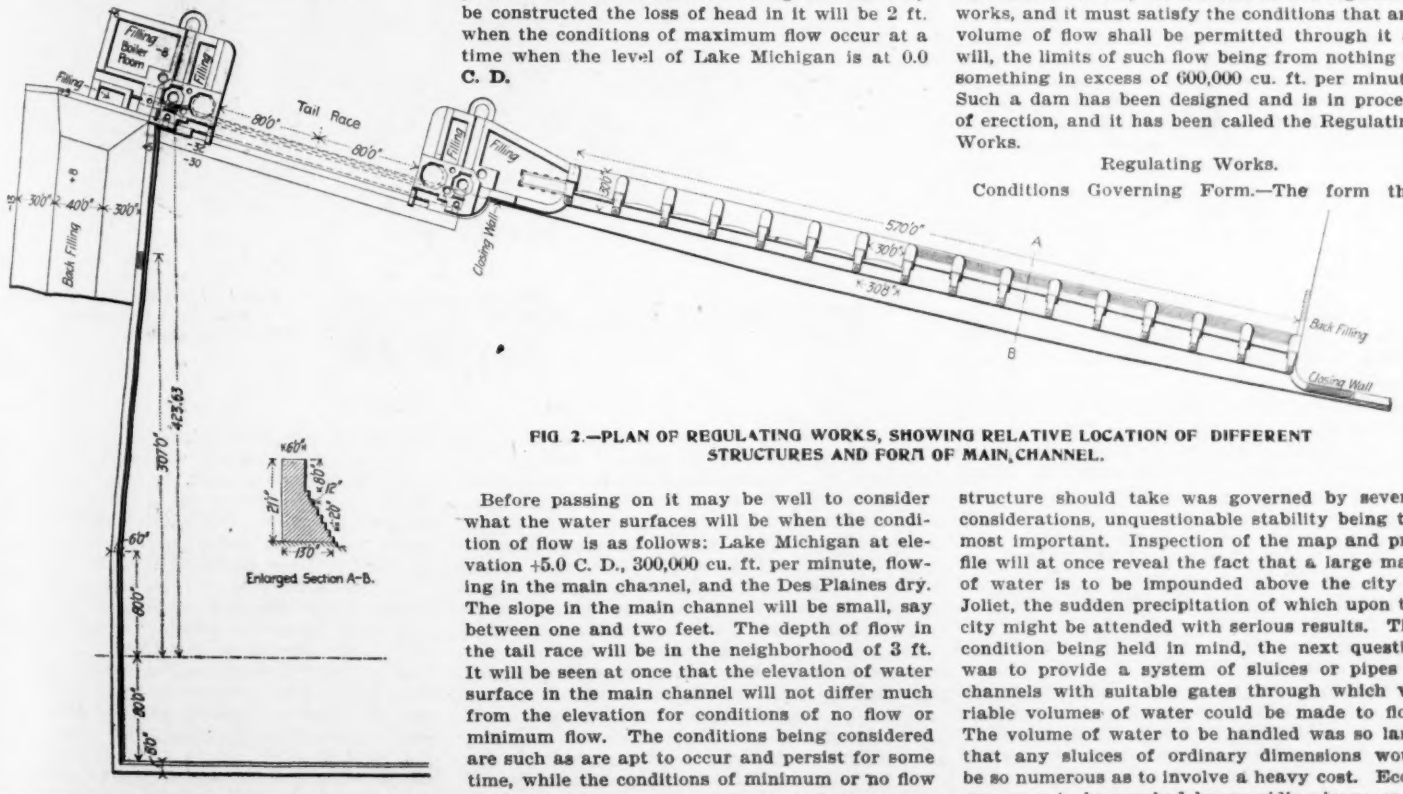


FIG. 2.—PLAN OF REGULATING WORKS, SHOWING RELATIVE LOCATION OF DIFFERENT STRUCTURES AND FORM OF MAIN CHANNEL.

Before passing on it may be well to consider what the water surfaces will be when the condition of flow is as follows: Lake Michigan at elevation +5.0 C. D., 300,000 cu. ft. per minute, flowing in the main channel, and the Des Plaines dry. The slope in the main channel will be small, say between one and two feet. The depth of flow in the tail race will be in the neighborhood of 3 ft. It will be seen at once that the elevation of water surface in the main channel will not differ much from the elevation for conditions of no flow or minimum flow. The conditions being considered are such as are apt to occur and persist for some time, while the conditions of minimum or no flow are not apt to occur except in case of emergency. Providing for one, it will be seen, is, however, about the same problem as providing for both.

Under conditions of maximum flow it will be seen that the water level immediately above the site of the regulating works is but ½ ft. higher than it is immediately below, and that the depth of flow at this site is between 7 ft. and 8 ft. If the necessary flow is to take place under these conditions of head and depth, a greater or less width of channel will be needed. And if the conditions of flow would never be otherwise than this if, as above assumed, Lake Michigan be at level +5.0 C. D., and the flow in the main channel be 300,000 cu. ft. per minute, except that openings would be needed in the dam to let pass the 300,000 cu. ft. per minute.

A little thought will show that the conditions of water surface, which may be required at any time, between the extremes noted, are variable. Then conditions of water surface will depend upon the elevation of Lake Michigan between 0.0 and +5.0 C. D., and upon a flow varying between 300,000 and more than 600,000 cu. ft. per minute. In order to be able to maintain any one of these many elevations of water surface a dam of some nature is necessary at the site of the regulating works, and it must satisfy the conditions that any volume of flow shall be permitted through it at will, the limits of such flow being from nothing to something in excess of 600,000 cu. ft. per minute. Such a dam has been designed and is in process of erection, and it has been called the Regulating Works.

Regulating Works.

Conditions Governing Form.—The form this structure should take was governed by several considerations, unquestionable stability being the most important. Inspection of the map and profile will at once reveal the fact that a large mass of water is to be impounded above the city of Joliet, the sudden precipitation of which upon the city might be attended with serious results. This condition being held in mind, the next question was to provide a system of sluices or pipes or channels with suitable gates through which variable volumes of water could be made to flow. The volume of water to be handled was so large that any sluices of ordinary dimensions would be so numerous as to involve a heavy cost. Economy was to be reached by providing large openings, the larger the better. At the same time the controlling gates must be of a kind easy to move. Again, while a part or the whole of the flow might be conveniently handled through pipes or sluices controlled by gates with an under flow, it was deemed desirable that there should be at least one opening such that the water would flow freely over the top of the gate. This would permit the sluicing of drift and ice from the surface of the main channel into the tail race. A matter of further concern was as to the volume of water for

which flowage room should be provided through the regulating works, for, while the main channel was designed for 600,000 cu. ft. per minute, still its capacity may prove to be in excess of that volume and sanitary reasons may make it desirable to utilize the full capacity of the channel. And still again, there being a number of openings for the flow contemplated, it was deemed desirable that the possibility of one or more of them being under repairs and out of use should be anticipated.

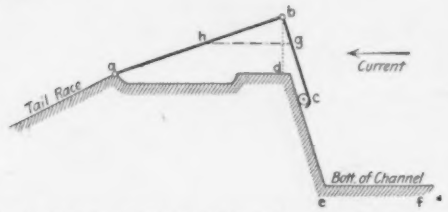


Fig. 3.—Diagram Explaining General Design of Bear Trap Dam.

It will be noted that the grade at the bottom of the main channel at the site of the regulating works is —30.0 C. D., while the bottom of the tail race is 15 ft. higher, or at elevation —15.0 C. D. The alternative of discharging the water over a sill at the level of —15.0 C. D., or discharging it in such way that egress would take place at the bottom of the main channel, at —30.0 C. D. was presented. The latter method might prevent the deposit of silt or sludge on the bottom of the main channel, especially since the channel at this locality has a very large cross-section and will have a low velocity. The head available to cause flow would be the same in either case. Constructions providing area and hydraulic radius to permit the flow would evidently involve less labor and material if the discharge be made to occur over a sill at —15.0 C. D., and would, therefore, be less costly. Furthermore, if there should be any tendency to silting, either manner of effecting the discharge would not influence such tendency but a few feet upstream from the discharging channels, and, therefore, it would be better occasionally to remove the deposits of silt by dredging or otherwise than to incur the expense and inconvenience of inaccessible submerged outlets, which must necessarily be numerous, sufficiently numerous to offer an area of several thousand square feet for flow. Finally, if deposits of silt are to take place in the main channel, which is by no means a probability if the full flow of 600,000 cu. ft. per minute be provided, such silting will in the main occur in the large cross-section and low velocity that will exist east of Willow Springs, and a number of miles above the regulating works. It was therefore concluded that the discharge from the main channel should occur above alevation —15.0 C. D.

The alternative of discharging the water at the end of the main channel, or at its west side, was presented. There was not width enough at the end to provide for all the discharge. Again, it was not desirable to occupy the end of the channel with such works, for they would be an obstacle in the way of extending the deep channel for navigation in the future. Finally, the desirability, for reasons of economy, of joining the waters of the main channel and Des Plaines River, near the head of the tail race dictated regulating works at the west side of the channel. Such a location was therefore made.

The form of openings to facilitate discharge, and a number of them were needed, was evidently a number of rectangular channels with their floors at elevation —15.0 C. D., divided one from another by piers raising above the highest water. Anything in the form of pipes would have been very costly because the head available for conditions of maximum flow would be so small as to require an enormous area of cross-section. The rectangular openings would give the least hydraulic radius practicable, and, therefore, higher velocity.

Form Adopted.—This conclusion being reached, the style of gate to control flow remained to be determined. The available styles worthy of application were the bear trap, the Parker-Tainter and the vertical sliding gate, such as was adopted. The first two would permit wider openings between piers, and if the nature of the case had been such that the failure of one or more gates would not be attended with results more serious than the cost of replacing the gate, as in the case of the Nevers dam, in the St. Croix River, they would doubtless have been the best form, especially the Parker-Tainter form. They were, however, deemed to have elements of design not suitable to the limiting conditions. Bear traps, as ordinarily constructed, have structural elements of an objectionable nature, as will be set forth more in detail further on, to correct which involves an expense which would render them more costly than either of the other forms. The vertical sliding gate adopted closes an opening 30 ft. wide, and, as already stated, of necessity 20 ft. high. The cost of a Parker-Tainter gate of the same dimension, and of equally substantial construction and made of metal would not be materially different, all things considered, and could be operated or repaired with equal facility. To construct either form with larger dimension would have been departing in an unnecessary degree into the realm of experiment, though neither has any material advantage over the other as far as facility for varying the size of gate is concerned. The Parker-Tainter gate, however, involved carrying heavy pressures to an axle while with the sliding form the pressures due to the load are distributed over larger surfaces. This form seemed, therefore, to be the most conservative design and was adopted. The dimensions adopted for the opening for discharge, 30 ft. wide by 20 ft. high, was governed by consideration of the facility of operating the gate and of the stability of the structure when passing large volumes of water under high velocity when the stream is throttled by the gate. As designed, two men can lift or lower the gate by hand. Mechanical power for operating the gates was not deemed best because they will not often be moved.

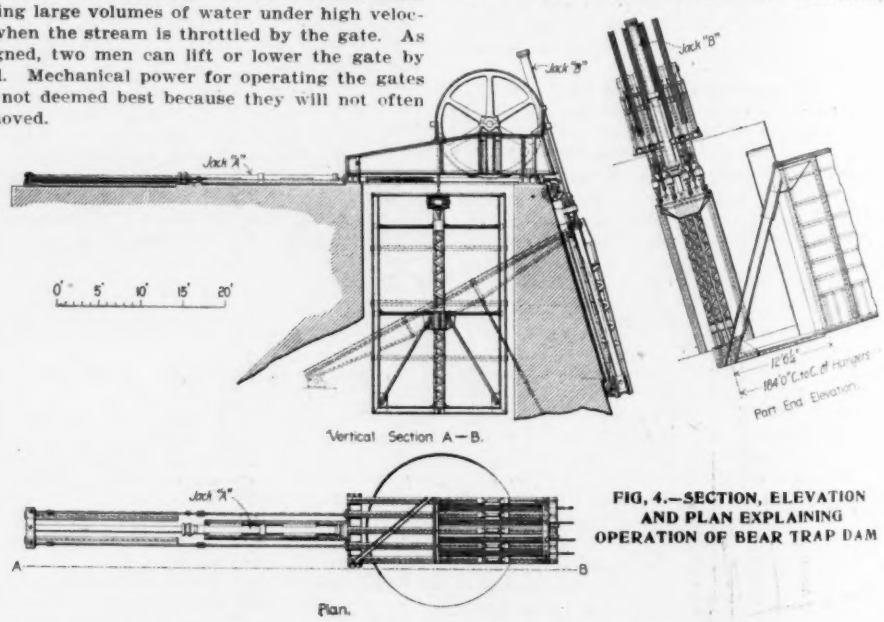


FIG. 4.—SECTION, ELEVATION AND PLAN EXPLAINING OPERATION OF BEAR TRAP DAM

The determination of the actual number of openings to provide was not a problem to be solved easily. The head available for flow was 0.5 ft. It could be increased to 0.75 or 1.0 ft. without materially affecting the capacity of either the main channel or tail race. No great mistake would be made if the number was made ample. The ultimate flow through the channel was necessarily uncertain, and probably in excess of 600,000 cu. ft. per minute, which argued in favor of an ample number. Perhaps the most important consideration was that the larger the number of gates the less the velocity, ultimate conditions of flow being held in mind. The result might be a somewhat less depth than 7½ ft., but not much less, for as the flow through the gates would be greater the more the depth in the tail race would be. A velocity of 5 ft. per second would be entirely consistent with durability of masonry and would provide for a flow of from 800 to 1,000 cu. ft. per second through each gate, or 12,000 cu. ft. for 15 gates. After consideration this number of gates was settled upon. The location of these gates is shown by the plan, Fig. 2, and full details of their construction were published in Engineering News of Nov. 21 and Dec. 12, 1895.

The sluice gates being disposed of, the question of a gate permitting flow over the top presented itself. The crest of the gate must rise to elevation +5.0 C. D., or a little higher, and must lower to below elevation —8.0 C. D., or low water in the channel. It must permit of easy flow of debris and ice over its crest. A depth of flow of 3.5 ft. was deemed sufficient for this purpose, so that the crest would have to be lowered to —11.5 approximately. It was finally decided that the gates should be so designed that its crest might be made to have any elevation between +6.0 C. D. and —11.5 C. D. The width of opening could not be as definitely determined. Greater or less width might be good enough. It was finally determined, however, that it should have the minimum width of the main channel where cut in the rock, or 160 ft. A structure of this kind being of somewhat an experimental nature, it was concluded that it should not be relied upon as a constant outlet from the channel. In other words, its function must be simply to provide an overflow for ice and debris.

The only form of gate answering the requirements was the bear trap, or gates involving essentially the principle of the bear trap, viz.: That it should be operated mainly by the head of water between the main channel and the tail race. Many forms of gates were suggested and considered. Inspection was made of existing forms, the old style, the Parker and the Lang. These all presented defects that rendered them doubtful structures for such an important location. The defects were of two kinds: (1) The crests of such dams could not be relied upon to rise and fall parallel to themselves, in consequence of which the structures would be subject to more or less wrenching. This being true for smaller, timber-made gates, it was feared that it might be fatal to so large a structure. At any rate it was concluded that this defect should, if possible, be avoided. (2) The head of water between the upstream and downstream sides of gate would not be sufficient at all times, that is, at low water in the channel, to operate the gates, especially if made of metal.

To obviate the first of these difficulties it was necessary that the form of gate should be such that, when in motion, it could be rigidly held so as to insure parallel motion. This could be done by providing a sufficiently rigid member, and in no other way. The second difficulty could be overcome by counter-weighting in a suitable manner, and this could not be accomplished except by aid of a rigid member. A simple construction, such as that adopted, would accomplish all of this, and as nothing better suggested itself, plans were drawn accordingly.

Bear Trap Dam.

Location.—In Fig. 2 is shown a plan of the regulating works, and by it the relative location of the bear trap dam and the sluice gates is clearly shown. It will be noticed that the spaces for eight of the sluice gates are walled up, this being because it was deemed advisable to install at first only such a number of gates as will be immediately demanded, but still have the construction completed to such an extent that additional gates can

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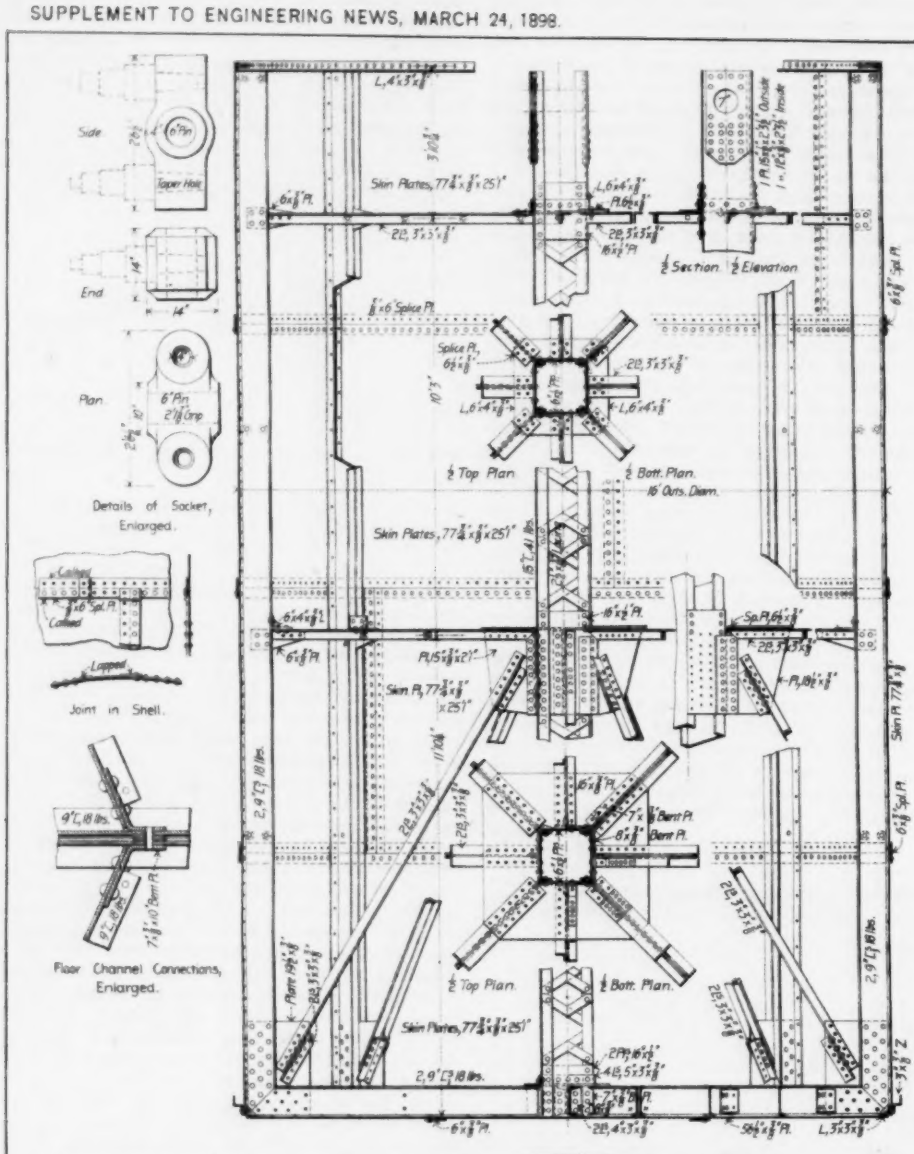


FIG. 15. DETAILS OF COUNTERWEIGHT BUCKETS.

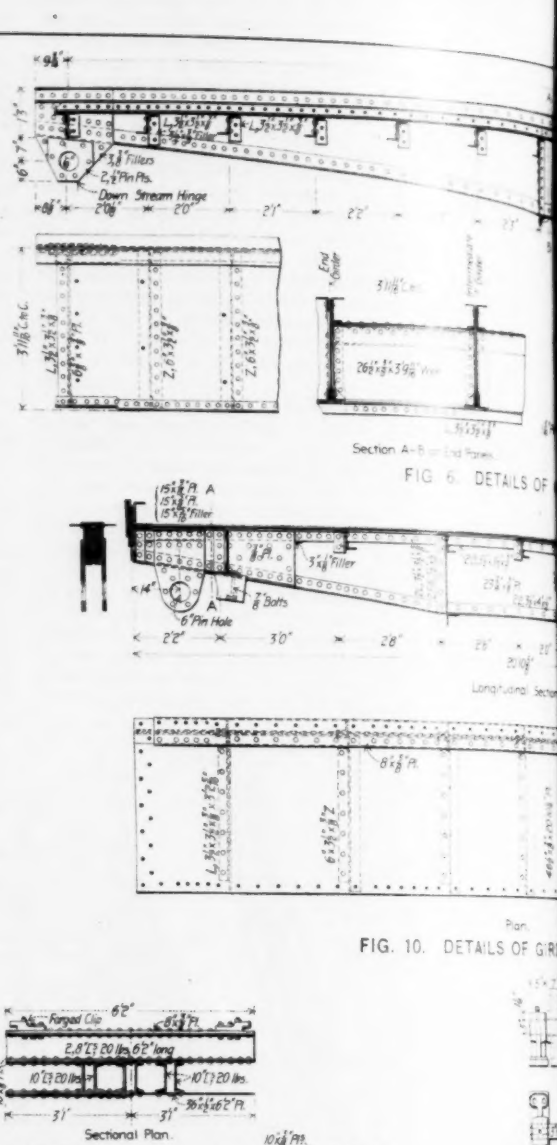


FIG. 10. DETAILS OF GIRD

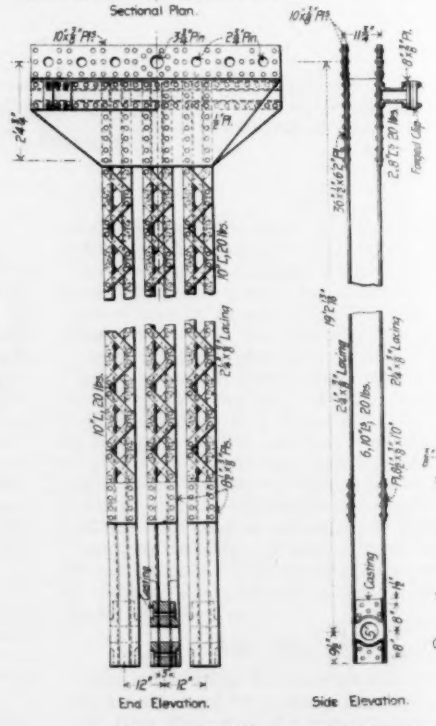
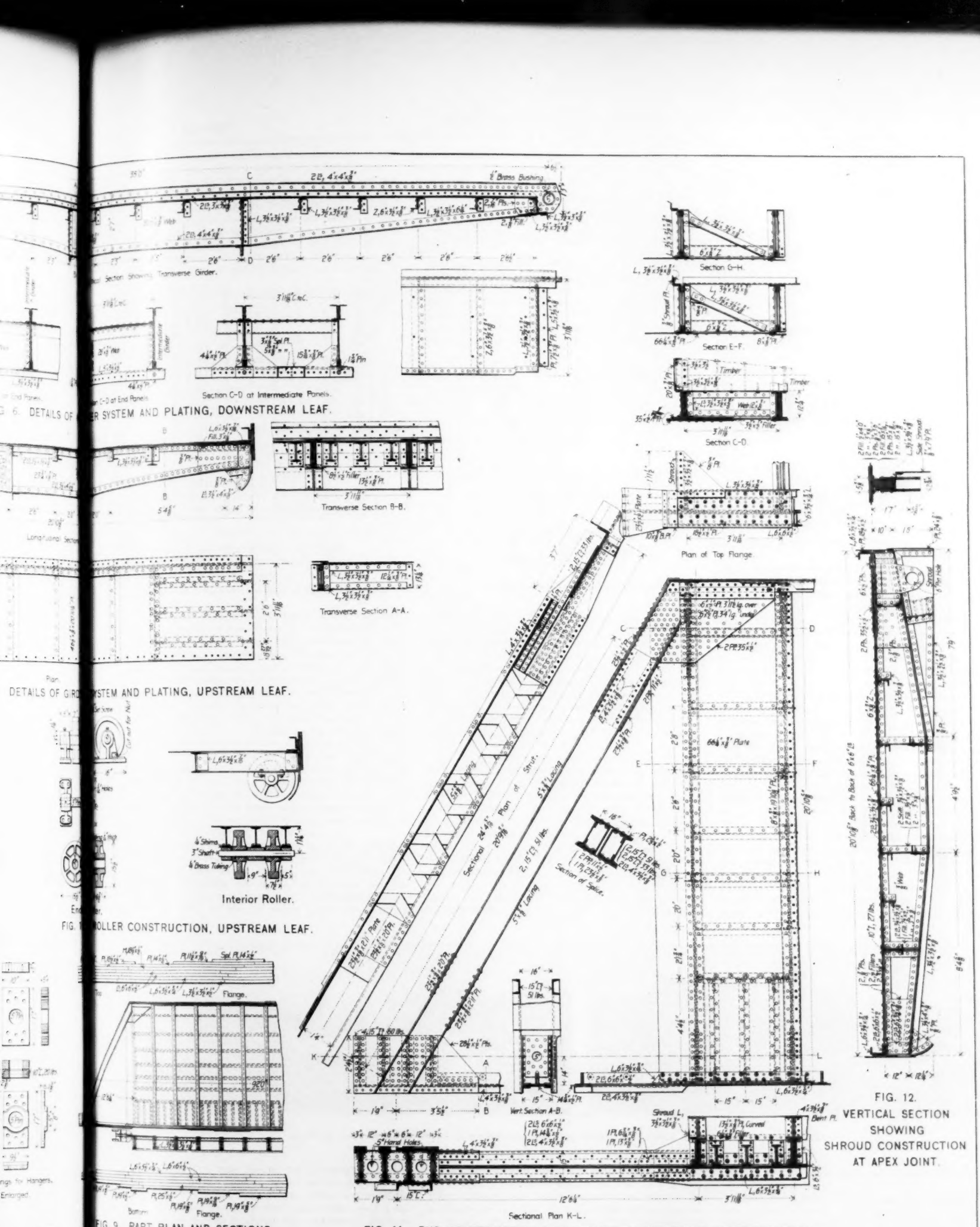


FIG. 14. DETAILS OF HANGER, UPSTREAM LEAF.

BEAR TRAP DAM, CHICAGO MAIN DRAIN

Isham Randolph, Chief Engineer.
Thos. T. Johnston, Assistant Chief Engineer. } Sanitary District of Chicago.



DETAILS OF GIRDER SYSTEM AND PLATING, DOWNSTREAM LEAF.

DETAILS OF GIRDER SYSTEM AND PLATING, UPSTREAM LEAF.

FIG. 9. PART PLAN AND SECTIONS OF UPSTREAM LEAF.

FIG. 11. END CONSTRUCTION FOR HANGER CONNECTIONS, UPSTREAM LEAF.

FIG. 12. VERTICAL SECTION SHOWING SHROUD CONSTRUCTION AT APEX JOINT.

MAIN DRAINAGE CHANNEL. (SUPERSTRUCTURE.)

Christie & Lowe, Chicago, Ill., Contractors.

Alfred Noble, M. Am. Soc. C. E., Designer of Metalwork Details for Contractors.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

be placed quickly whenever the volume of flow may reach such an amount as to demand them.

General Design.—The general design adopted for the bear trap is shown by Fig. 3, and also by Fig. 4, the disposition of the bottom of the channel with reference to the bottom of the tail race permitting this form of construction. Referring to Fig. 3, the maximum value of b d was given, which practically determined the distance b c, except as varied by purely structural reasons. It

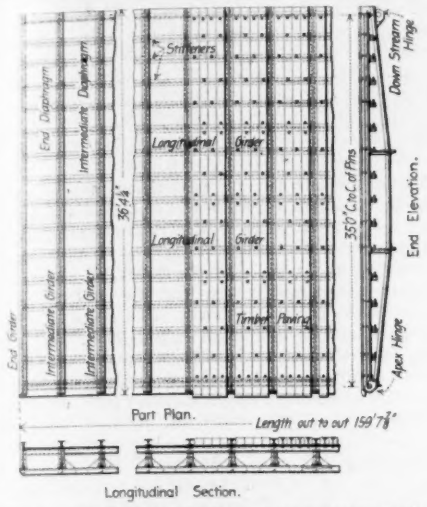


Fig. 3.—Part Plan and Sections of Downstream Leaf.

remained to determine the distance a b, the permissible value of the angles a b c and d e f, and the form of the line d e. The mechanics of these operations are plain enough, but the mathematical work was tedious and extensive. An exposition of the latter would involve a number of diagrams, explanations, equations and numerical calculations without evolving anything but some dense operations in pure mathematics, and may be omitted at this time. It was found that the loads and the structure would be lighter if a b be made about 35 ft., as it was finally made. The angle d e f proved most advantageous when d e was inclined on a slope of 3 horizontal to 10 vertical. The point a was so disposed that b c would be about parallel to d e when at the highest and lowest positions. It was found that a rectilinear form was the best adapted for the line d e.

The weight of the structure, under its heaviest loading, was duly determined, and then an examination of the power needed for operating was made. The dam was assumed to have various positions, with various quantities of water flowing over it. The surface of water under the dam, as at g h, which was needed for equilibrium of the structure in the several instances was determined, friction not being considered. Then assumptions as to the amount of friction were made, and a determination was made of the change of level of g h that would be required to cause the dam to rise or fall. This study led to giving a diameter of 2 ft. to the rollers at c. It was found that, at its lower positions, it was likely that the dam could not be operated unless counterweighted, or otherwise made lighter.

Detailed Design.—The detailed design for the bear trap proper (including, broadly, everything but the machinery and the purely foundation masonry and attached metal work) was left to the contractor, the specifications stating:

> The contractor must submit detailed designs for the construction of the metal work called for by the plans, such designs to conform to the limitations hereinafter specified and to be approved by the engineer, and to be accepted by him in writing. The design shown on the plans is simply intended to indicate the general nature of the construction.

The limitations referred to in the specifications will be evident from the description which follows and need not be stated here. The contractors were Christie & Lowe, of Chicago, Ill., and their designing engineer was Mr. Alfred Noble, M. Am. Soc. C. E. With this explanation the detailed design will be described without further delay.

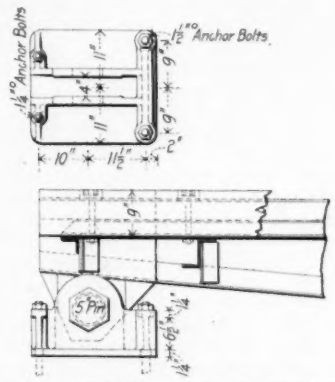


Fig. 7.—Foundation Hinge for Downstream Leaf

Superstructure.—Before entering into a description of the counterweight system and other mechanism by which the operation of the dam is controlled, it is desirable to examine some of the structural features of the dam structure proper, and to this end the superstructure as distinguished from the foundations will be considered first. Referring to Fig. 4, it will be seen that the dam consists of an upstream and downstream leaf hinged together; the downstream leaf being also hinged at its lower edge to the foundations.

Fig. 5 shows a part plan and sections of the downstream leaf, from which it will be seen that it is made up of a system of transverse and longitudinal girders reinforced by intermediate longitudinal stiffeners and covered with a plating of steel paved with timber. Fig. 6 shows enlarged details of the girder system, stiffeners and plating, and gives the salient dimensions. Each transverse girder carries two hinges; that is, a downstream hinge, Fig. 7, and an apex hinge, Fig. 8. The weight of the downstream leaf, not including the timber floor, is 299,000 lbs. Its total weight is 509,000 lbs. Fig. 9 is a part plan and longitudinal section of the upstream leaf, which is made up similarly to the downstream leaf, but is proportionately much heavier in order to provide the strength as a plate girder, which it is required to have. Fig. 10 shows the girder system and plating in more detail. The weight of the upstream leaf, including rollers, etc., is 338,000 lbs. The particular features of this leaf, however, are: The end details whereby the leaf is attached to the counterweights; the shroud construction by which leakage is prevented at the apex hinge, and the roller bearing and joint, Fig. 11, shows the end construction and its position in relation to the remainder of the leaf is further explained by Fig. 9. Figs. 12 and 13 show the shroud and roller construction.

Referring yet to the upstream leaf it will be seen from Fig. 4 that its peculiar end construction is designed solely to afford a connection for the counterweights which aid in operating the dam. To the outer apex of the knee brace is attached a framed hanger, and to the top of this hanger are attached the steel ropes which pass over sheaves and fasten to the counter-weights. Fig. 14 is an enlarged detail drawing of this hanger, whose peculiar construction needs a brief explanation. It will be noticed from Fig. 4 that the hanger serves as a strut to take the pressure of the hydraulic jacks provided to secure parallel motion, as will be described further on. For this duty rigidity was required, but too great rigidity might not be a desirable feature for other reasons. Expansion due to temperature, warpage, non-parallel motion, etc., of the 160 ft. upstream leaf, while they might not and in fact were almost sure

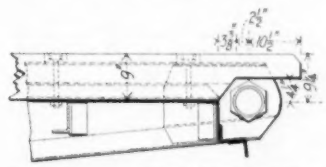


Fig. 8.—Apex Hinge for Downstream Leaf.

not to be large, required some provision for lateral motion on the part of the hangers, in the light of conservative construction. The design shown by Fig. 14 was considered suitable to subserve both duties. The three lateral struts are held rigidly together only at the ends, and while very stiff longitudinally have considerable capacity for motion laterally or perhaps better flexurally. It will be seen that the longitudinal motion of the strut with the raising and lowering of the dam is insured by means of guides attached to the masonry, Fig. 4. There are two of these hangers, one at each end of the upstream leaf.

To the cross-head of the hangers are attached the four steel ropes which pass over the sheaves to the counterweights, and also two cables which connect with the hydraulic jack system, to be described later. The sheaves, Fig. 4, are four in number at each end of the dam, or eight altogether, and they are carried by four parallel girders, firmly braced together and resting on cast-iron chairs bolted to the girders and also anchored to the masonry. Details of these sheave girders are not given, as they are of ordinary plate girder construction, nor is it necessary to describe the sheaves further than to say that they are of cast-iron, 12 ft. 3½ ins. in diameter, on pitch line, and have 10-in. forged steel, turned and polished shafts working in cast-iron, phosphor bronze-bushed bearings.

Counterweights.—This brings the description to the counterweights, of which there are two, one at each end of the dam, and located as shown by Fig. 4. Each counter-weight is simply a hollow steel cylinder or bucket of the dimensions and construction shown by Fig. 15. Attention needs to be directed only to the elaborate interior bracing and the method of attaching the steel ropes holding the cylinders in suspension. The theory of operation of these counterweights will be explained further on, but here it need only be noted

VIEW OF SITE OF BEAR TRAP DAM SHOWING ON THE RIGHT THE SLUICE GATES UNDER CONSTRUCTION.

that their rigid construction was required to resist the water pressure and to sustain the iron weights with which they will be partly filled. The weight of each counterweight bucket without ballast is 55,000 lbs., and with ballast 325,000 lbs.

Material.—The construction thus far described is almost entirely plate and shape work, employing cast and wrought-iron and steel. The following is a brief abstract of the specifications for these materials

Metalwork.—No specific process of manufacture will be demanded, provided the material fulfils the requirements of these specifications. The tensile strength, limit of elasticity and ductility shall be determined from a standard test piece of as near ½-sq. in. sectional area as possible. The elongation shall be measured on an original length of 8 ins. Iron of all grades shall have an elastic limit of not less than 26,000 lbs. per sq. in.

Material	Ult. strength, lbs. per sq. in.	Elong. in 8 ins. at fract. Per cent.	Red. area at fract. Per cent.
Iron:			
High-test or tension	50,000	18	....
Angle and shape iron	48,000	15	....
Plates, 8 to 24 ins.	48,000	15	....
Plates, 24 to 36 ins.	46,000	10	....
Plates, over 36 ins.	....	8	....
Rivet iron	50,000	18	....
Pin iron	50,000	15	....
Steel:			
Mild steel	60,000	25	45
Rivet "	60,000	25	50
Pin "	60,000	20	40

Specimens taken from bars of a larger cross-section than 4½ sq. ins. will be allowed a reduction of 500 lbs. for each additional square inch of section, down to a minimum of 48,000 lbs. and have an elongation of 15% in 8 ins. All iron for tension members must bend cold through 90° to a curve whose diameter is not over twice the thickness of the piece without cracking. At least one sample in three must bend through 180° to this curve without cracking. When nicked on one side and bent by a blow from a sledge the fracture must be mostly fibrous.

Specimens from angle and other shaped iron must bend cold through 90° to a curve whose diameter is not over twice the thickness of the piece without cracking. Samples of plate iron shall stand bending cold through 90° to a curve whose diameter is not over three times its thickness without cracking. When nicked and bent cold the fracture must be mostly fibrous. Full-size pieces of flat, round or square iron not over 4½ ins. in sectional area shall have an ultimate strength of 50,000 lbs. per sq. in. and stretch 12½% in the body of the bar. Bars of a larger sectional area than 4½ sq. ins. will be allowed a reduction of 1,000 lbs. per sq. in. down to a minimum of 46,000 lbs. per sq. in. and stretch 10% in the body of the bar. In all cases the amount of phosphorus contained in steel shall not exceed 0.1%. Specimens of mild steel from finished material for test, cut to size specified above, shall have an ultimate strength of 60,000 lbs. per sq. in.; a deviation of 4,000, more or less, than 60,000 will be allowed; minimum elastic limit, one-half the ultimate strength; minimum elongation, 25% in 8 ins.; minimum reduction of area at fracture, 45%.

Before or after heating to a cherry red and quenching in water at 82° F. this steel shall bend 180° to a diameter equal to thickness of the piece tested without sign of fracture. Any rivet hole for ¾-in. rivet punched in ordinary practice (with center not more than 1¼ in. from edge of piece) shall stand drifting to a diameter 25% greater than the original hole without cracking, either in the periphery of the hole or in the extreme edges of the piece, whether they be sheared or rolled. Rivets shall bend cold 180°, with sides to close contact without sign of fracture, and shall stand the quenching test at a bright yellow heat.

All steel castings shall have the properties and meet the requirements given in what follows, unless otherwise specified: The amount of phosphorus contained shall not exceed 0.1%; the ultimate strength shall not be less than 60,000 per sq. in.; minimum elastic limit, 25,000 lbs.; minimum elongation, 15%. All steel castings shall be sound and free from injurious roughness, sponginess, pitting, shrinkage cracks or other cracks, cavities, etc., and shall be thoroughly annealed according to good practice.

When not otherwise specified, all iron castings shall be tough gray iron, sound and free from injurious cold shuts and blowholes, true to pattern and of workmanlike finish. Sample pieces 1 in. square, cast from the same heat of metal in sand molds, shall be capable of sustaining on a clear span of 4½ ft. a central load of 500 lbs. when tested in the rough bar.

The specifications for workmanship do not differ materially from those for ordinary first-class work of this character. It is required that all metal before leaving the shop shall be thoroughly cleaned and be given one coat of pure linseed oil; that all surfaces in contact shall receive one heavy coat of approved paint before assembling, and that all finished surfaces shall be coated with white lead and tallow before leaving the shop. After erection all iron and steel work are required to be thoroughly and evenly painted with two coats of paint of a quality and color approved by the Chief Engineer.

In a succeeding article the illustration and description of the bear trap dam will be concluded. For the information from which the article and illustrations have been prepared we are largely indebted to Mr. Thos. T. Johnston, Assistant Chief Engineer, Sanitary District of Chicago, under whose immediate direction the regulating works were designed. Credit to the engineers having particular parts of the work in charge can be given better in the concluding article and will be deferred until then.

SEWAGE PURIFICATION BY INTERMITTENT FILTRATION AT SPENCER, MASS.

About a dozen cities and towns in Massachusetts have established sewage purification plants, the latest one being Spencer. With the exception of Worcester all these places dispose of their sewage on land, and Worcester is now preparing to give the same kind of treatment to the effluent from its chemical precipitation works, as was stated in our issue of Nov. 25, 1897.

A gravity water supply and a separate system of sewerage were introduced in Spencer in 1883. Since that time a number of catchbasins have been built and connected with the sewers. Some of these have been cut off since it was decided to treat the sewage and it is proposed to cut off all of the remainder. A considerable amount of ground water finds its way into the sewers, which were laid without underdrains.

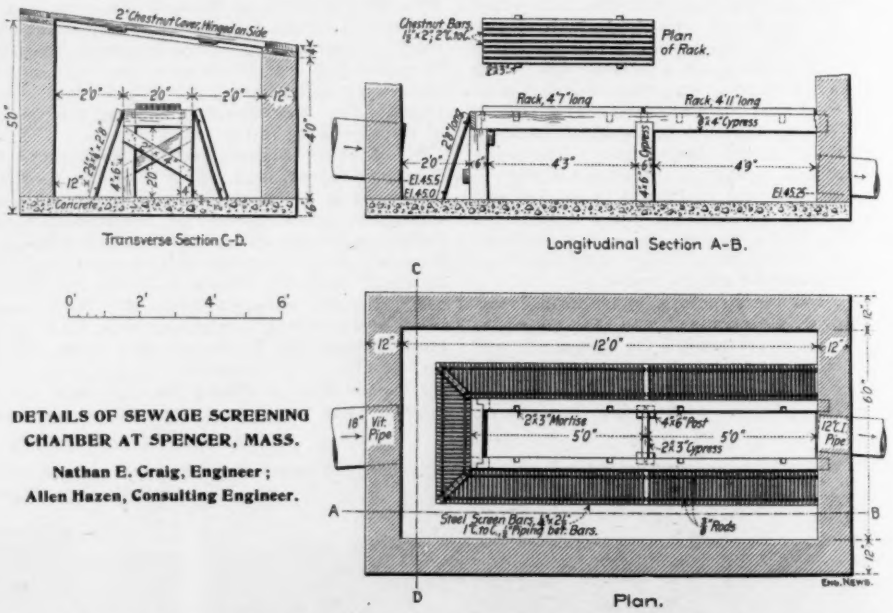
There are now about seven miles of sewers tributary to the outlet leading to the filter beds, besides which a small amount of sewage goes to the river through a second outlet, discharging about one mile above the beds. The sewage from the smaller district will not be treated. In August, 1896, a careful canvass of the portion of the village that is or may be served by the sewers of the larger district showed a population of 5,016 persons, an average of 4.7 per tenement. There were at the same time 118 vacant tenements. Of the actual population of 5,016 there lived in houses connected with the sewers 2,855 people, while all but 293 were in houses provided with water from the public works. By weir measurements made in 1896 it was found that the minimum daily flow of sewage was 250,000 gallons. The daily flow after a week of wet weather was 500,000 gallons and the average daily flow in ordinary weather was about 400,000. As the surface water can be excluded from the sewers at but slight expense the volume of flow to be treated, with the present length of sewers and tributary population, is assumed as 400,000 gallons per day. A large part of this is ground water, since the dry weather flow was but 250,000 gallons per day, while a per capita allowance of 60 gallons per day would give only 170,000 gallons for the total flow. When the laterals are extended through the whole of this sewer district it is estimated that 6,000 persons will be living in the district.

As has been stated, the first sewers were built in 1883. At the town meeting in 1893 Mr. Nathan E. Craig, Superintendent of Sewers, an engineer located in Spencer, was instructed to investigate the subject of some improved means of sewage disposal, it being apparent that Seven-Mile River was insufficient in volume to receive the increasing amount of crude sewage being discharged into it. After consultation with the State Board of Health the matter was brought up in successive town meetings and authority granted for making necessary surveys and employing a consulting engineer. The firm of Noyes & Hazen, of Boston, was consulted by Mr. Craig, and after the death of Mr. Noyes the plans finally adopted were approved by Mr. Hazen. In 1897 the town voted $20,000 for the purchase and preparation of land for filter beds and the construction of an iron pipe line to the beds. Bids for the work were received on Aug. 19, 1897, as given in detail in our Contract Prices on Aug. 26. The contract was awarded to Newell & Snowling, of Uxbridge, Mass., for laying the pipe to the disposal area and constructing the beds. Some of the principal unit prices for the work on the beds, with approximate quantities, were as follows: 1,400 ft. of 4 and 5-in. underdrain, 11 cts.; grubbing eight acres, $50 per acre; 48,000 cu. yds. excavation, 15 cts.; 2,000 cu. yds. rolling, 5 cts.; plowing four acres, $4 per acre; plowing and harrowing nine acres, $6 per acre.

The aggregate amount paid the contractors was $9,709, of which $1,400 was for laying the outlet pipe to the beds. The total cost of disposal works, including the diverting manhole, screening chamber and outlet pipe, was about $17,250. The difference between this sum and the contract price includes the following items: Diverting manhole, screen chamber and flush pipe, $294; cast-iron pipe, $2,102; special castings, gates and gate boxes, $306; vitrified sewer pipe, $546; day labor, $1,035; engineering, inspection and legal expenses, $1,262; land, $1,600; sundries, $388. Of the $8,309 paid the contractors for labor in constructing the beds $7,211 was for excavation; $392 for grubbing, and $415 for the distribution and underdrainage system. The total cost of the work was 12.5% below the estimate, and the contract work overran the estimate for that part of the job by about $30 in $9,700.

The sewage is turned to the new pipe line and filter beds by means of a diverting manhole, cypress stop planks being used to turn the flow from the old outlet sewer to the river. At the head of the pipe line is a screening chamber, shown in detail by the accompanying illustrations. The screens in this chamber may be cleaned by raking the matter retained by them up onto the platform, from which they may be shoveled off.

The pipe line from the screening chamber to the gate chamber at the beds is of 12-in. cast iron, 3,127 ft. in length. The pipe is under pressure, the rate of flow is estimated at only 1 ft. per sec. Blow-offs are provided at two low points, and at each of these a filter bed with an area of about 10,000 sq. ft. has been built. A 2-in. water pipe, 1,000 ft. long, from the town main has been laid to the head of the new sewer, and from this water can be admitted to the sewer under a head of 60 to 70 lbs. In case of stoppage in the iron pipe the sewage will go over the stop plank into the old outlet to the river. At Gardner, Mass., there is also a cast-iron inverted siphon on the sewer leading to the filter beds, for which a blow-



DETAILS OF SEWAGE SCREENING CHAMBER AT SPENCER, MASS.

Nathan E. Craig, Engineer; Allen Hazen, Consulting Engineer.

off and small filter bed was provided. We believe the blow-off has been used but a little.

The town bought 22.9 acres of land for its disposal area, of which about eleven acres is covered with beds, giving some eight acres of available filtering surface. The purchase included a house, which will be occupied by the man who has charge of the beds. The beds are surrounded by the river on one side, by a swamp on two sides and a highway on the other side, giving no opportunity for extension. There is other land in the vicinity that can be used, but it is not so well suited to the purpose as this. The beds are located about 1½ miles from the center of the village. There are but one or two houses nearby.

The area has been laid out in twelve beds, which, to the center of the embankments range from 0.38 to 1.07 acres and average a little under one acre in area. About three-fourths of the area in beds is 12 ft. above high water in the mill pond on the river. One bed is 8 and another is 7 ft. above high water. These two beds adjoin the river and in each about 500 ft. of 4 and 5-in. tile underdrains have been laid, the joints being left open, with no collars, and wrapped with cheap cloth. The underdrains are about 5½ ft. below the surface of the beds.

The general width of the beds is 150 ft., their length varying with the lay of the land and water. To provide for the even distribution of the sewage a ditch has been formed at each side of each bed by means of a slight embankment close by the main embankment, with openings to the bed 10 ft., c. to c. A 15-in. distributing pipe, of vitrified clay, extends down the center embankment. Brick distributing chambers are provided where needed, with iron flap gates made by the Coffin Valve Co., Boston, Mass., which also furnished the metal work for the screen chamber. The device for lifting the flap gates and fastening them in position is similar to that used at Plainfield, N. J., and illustrated in Engineering News of Sept. 10, 1896.

In constructing the beds the surface material was stripped off and placed in the embankments. In some spots poor material was found and replaced by that of a better grade. There are a good many stone in the natural material here. No attempt was made to remove these except as they were found in bringing the beds to grade. The material was handled but once.

The material of the beds has an effective size of from 0.2 to 0.5 mm., and averaging about 0.3 mm., or 0.12 ins. It is expected that it will effect a high degree of purification when receiving sewage at the rate of 50,000 gallons per day per acre, available area, or 40,000 gallons, including space in embankments. When the total sewage flow exceeds 400,000 gallons a day, with the present tributary population, it is thought that the excess can be turned into the river without damage, for, as Mr. Craig's report on Sewage Disposal states:

> The quantity of sewage will exceed this amount only after heavy rains and at times of melting snow in the spring, when the ground is saturated with moisture, and at these times the river itself is also swollen, so that the discharge of untreated sewage, for a short time, will not be excessive.

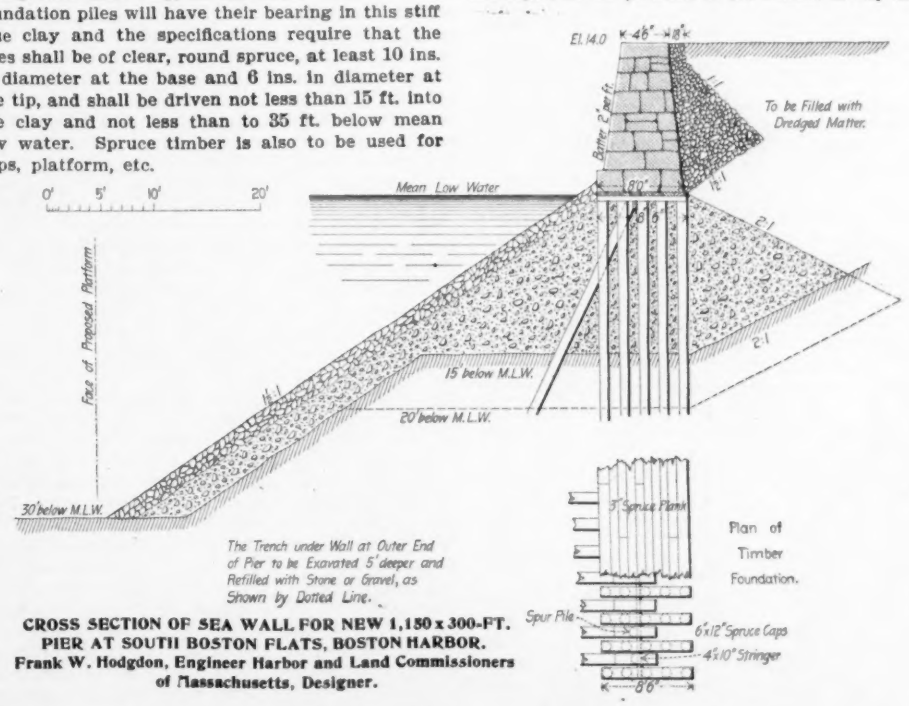
The increased flow due to seepage does not come so quickly after the beginning of heavy rain as is the case when surface water enters a sewerage system, and it is distributed over a longer time. The stream has an opportunity to reach its maximum flow by the time the seepage increases materially. The first heavy flow of surface water is likely to be badly contaminated with street washings, perhaps really needing purification almost as much as the house sewage. The tendency of the ground water flow is to cleanse the soil of any impurities that may lodge there. After a heavy rain following a dry spell, the amount of impurities carried by the ground water would naturally be above the average, but except for a highly polluted soil these impurities would add but little to those in the sewage proper, while in no probable event would the impurities reaching the sewers in ground water be as great as those in the first flow of surface water from populated districts.

The information given above regarding the Spencer plant was obtained for the most part from Mr. Craig, during a visit to Spencer by a member of the editorial staff of this journal, on Nov. 18 and 19. The beds were then nearing completion.

FILLED MASONRY PIER AT SOUTH BOSTON FLATS, BOSTON HARBOR, MASS.

We illustrate in the accompanying cut the cross section of the sea wall which is to inclose a filled pier to be constructed by the Harbor and Land Commissioners of Massachusetts, at South Boston Flats in Boston Harbor. The pier will run parallel to and 362 ft. from the present pier of the New England R. R. Co., and the sea wall will extend 225 ft. across the shore end of the slip between the two piers, entirely around the new pier, and then along the bulkhead line a distance of 200 ft. The new pier will be 1,150 ft. long and 300 ft. wide, which will make the total length of sea wall to be built 3,025 ft. When completed a dock platform, approximately 50 ft. wide, will be built around the outside of the sea wall.

The construction of the sea wall and piers is so fully shown by the drawings that only a few of the general features need to be mentioned here. It will be noticed that a trench is excavated along the site of the sea wall, and, after the pile foundation is built, is filled with ballast. Stone chips or coarse gravel may be used for ballast, and the harbor slope of the filling must be rip-rapped with larger stone. Directly back of the masonry wall there will be another prism of ballast to prevent the softer filling behind from bearing against and washing through the masonry. This back filling, which will occupy the entire space inclosed by the wall, will be material dredged from the bottom, which consists of black silt, silty sand, sandy clay and finally stiff blue clay, in the order named. The foundation piles will have their bearing in this stiff blue clay and the specifications require that the piles shall be of clear, round spruce, at least 10 ins. in diameter at the base and 6 ins. in diameter at the tip, and shall be driven not less than 15 ft. into the clay and not less than to 35 ft. below mean low water. Spruce timber is also to be used for caps, platform, etc.



CROSS SECTION OF SEA WALL FOR NEW 1,150 x 300-FT. PIER AT SOUTH BOSTON FLATS, BOSTON HARBOR. Frank W. Hodgdon, Engineer Harbor and Land Commissioners of Massachusetts, Designer.

The masonry is to be of good quality granite quarry stone of from 1 ft. to 3 ft. in thickness laid compactly, with good bond and full line and grade, and with all interstices filled with spalls. As will be noticed the cap stone will extend the full width of the wall, and the bottom course resting on the pile platform is also to be of selected large stone. At least one-fourth of the face stone are to be headers. Further details of the construction will be seen from the illustration. Altogether there will be about 9,810 cu: yds. of masonry in the wall proper. The other quantities which enter into the work are: 7,260 spruce piles, 172,000 B. M. spruce lumber; 13,500 cu. yds. of rip-rap; 58,100 cu. yds. of stone ballast filling; 260,000 cu. yds. of filling with dredged material, and about 11,560 lbs. of spikes, treenails and bolts.

The contractors for the pier proper are Perkins, White & Co., of Boston, Mass., and the contract price is $198,416. Work has already been commenced by the contractors. The contract for the 50-ft. platform has not yet been awarded, and in fact the design of this part of the structure has not been fully determined. The usual design adopted for such platforms in Boston Harbor is a pile trestle work with a timber and plank platform. Owing to the extremely long piles which will be required here, the question is being considered of constructing the platform of a steel frame, carried by concrete piers and having a timber platform, fender, etc. The work has been designed by Mr. Frank W. Hodgdon, Engineer of the Board of Harbor and Land Commissioners of Massachusetts. We are indebted to Mr. Hodgdon for the information from which this description has been prepared.

THE PASSAIC RIVER POLLUTION COMMITTEE of the New Jersey legislature has submitted a report in which it recommends further investigation of the subject, by still another committee, before the legislature decides on any plan of relief for the inhabitants of the Passaic Valley. The committee disapproves of the proposed outlet into Newark Bay, recommended by the special committee in 1897, and thinks the communities concerned show too little interest in the matter, and that the information available is too meager to warrant action at present. It recommends the passage of a bill, which we understand has been introduced in the legislature, providing for the appointment by the governor of three or more commissioners to investigate the pollution of any stream in the state, and to recommend plans for its prevention. The members of the commission would have a salary of $1,000 each. The commission would have power to expend not over $25,000, and to employ such assistants as it deemed necessary. There is nothing in the bill to compel the governor to appoint the commission, or to indicate when it shall report the results of its studies. The commissioners, once appointed, seem to be given ample power to study and report on the pollution of the Passaic or any other stream in the state. These indefinite features of the bill might not give rise to comment were it not for the fact that it has been currently reported from time to time that no definite steps towards cleaning up the Passaic Valley would ever be permitted until Jersey City had made a contract for a permanent water supply, since with a purified Passaic in prospect the city always has open to it the possibility of a filtered supply from the Passaic River. The state as a whole needs just such a commission and investigation, or series of investigations, as would be possible under this bill, but if immediate action in the Passaic Valley is desired it would seem wise to make the bill more specific in some respects.

AMERICAN GOLF CLUBS are now used in England and the following item from the "Liverpool Echo" is of interest in this connection:

> Most people will be surprised at the statement that we are now importing golf clubs from America; but it is a fact, according to the statement of Mr. Charles S. Cox, an Englishman long resident in America, who, on his return home, has stated that he had no difficulty in obtaining orders for 8,000 clubs from the largest dealers in golf goods in Scotland and England. The reason for this is asserted to be that the American clubs are better made and better finished than those that can be obtained at home at anything like the same price.

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Many of our readers will remember with pleasure the visit to this country last year of Mr. Nicholas Simin, Chief Engineer of the Water-Works of Moscow, Russia. Mr. Simin came to this country to study mechanical filtration. He was accompanied by his daughter, who acted as his private secretary. We have received from Mr. Simin a highly interesting letter in which he first of all expresses his appreciation of America and Americans. Mr. Simin states that his recollections of visits to other countries consist chiefly of "places, cities, buildings, which I have seen," but that while America "has a multitude of splendid and gigantic" structures "which have no equal in Europe," it is "the people whom I have met, my new American friends," that chiefly impressed him. He then names about fifty persons to whom he especially desires to extend his thanks.

Mr. Simin speaks very highly of mechanical filtration, and makes the following suggestions for improvements in mechanical filter plants, as now used in this country:

(1) For the thorough washing of mechanical filters mechanical agitators are used. Would it not be possible for the purpose of making filtration cheaper to arrange the filter plant so that the same agitating device might not be repeated in every filter? I mean, to use but one removable agitator, which could be placed in every filter when it is washed, and carried from one filter to another. I think it would be feasible, as many filter tanks are never washed at the same time, but always one after another.

(2) With sand filters of the European type it is found that the lower layers of sand, which are rarely changed, contain a certain amount of organic matter and bacteria, the so-called "biological formation," serving to make filtration more complete through oxidization. Would it not be desirable to keep this useful feature of the European filters also for the mechanical filters. In order to do this, all that is necessary is to arrange the washing-agitator so that it could, during the washing, agitate the sand only on its surface—say, to a depth of from 1 to 5 ins. The water during this process should not pass by a reverse current through the whole filter bed, but merely over its surface, and carry away the accumulated suspended matter. In that way it would be possible to secure not only a more efficient filtration, but also a reduction of the quantity of wash-water and of mechanical power for the agitating device. Sometimes, in cases of necessity, the whole sand-bed could be washed by a reverse current of water. But such cases won't be frequent, because, as I have seen, the mud remains chiefly on the surface of the sand-bed, and does not pass deeply into it.

The first suggestion might slightly cheapen the initial cost of a filter plant, but it would add somewhat to the labor and time of operation. As to the second suggestion, it would directly increase the cost of construction, by adding to the number of pipe connections and valves. To what extent, if any, it would lessen the amount of power and wash-water required could best be answered by experiments. We have always understood it to be necessary to wash the whole body of sand, from top to bottom. Of course, the top layers have most need of the washing, but if only these layers were washed doubtless the operation would have to be performed more frequently. As to any biological action in the lower layers of the filtering material, or elsewhere in a mechanical filter, we understand that the rate of filtration is too rapid for such action, regardless of the system of washing employed.

We leave Mr. Simin's suggestions to those engaged in designing and operating filter plants. We know that the suggestions, and the spirit which prompted them, will be appreciated in this country, and that those who had the pleasure of meeting Mr. Simin last fall will be glad to hear of his safe arrival home, and of his kindly words regarding America and Americans.

The present administration of the Navy Department is to be most heartily commended for its intelligent appreciation of past experience and present demands, in placing an engineer at the head of the Bureau of Yards and Docks, a purely technical division of the government service. We fully appreciate the pressure of long established custom against which this action had to be taken, and the powerful influences which were exerted to retain this office as a line-officer's perquisite. But the appointment of Mr. Endicott to this position only proves that with the present efficient heads of the Navy Department, business considerations and the true interests of the government and the people, for the first time in the history of this Department, outweigh all tradition and class influence. Aside from consideration of good policy in placing an engineer in charge of engineering work, the appointment in itself is a most excellent and fitting one. Mr. Endicott has been for twenty-four years continuously engaged in the work of designing and constructing docks and other public works for the government, and for the last eight years he has been directly connected with the administration of the Bureau of Yards and Docks at Washington, though without the power to direct and decide, which he will now possess. He is thus a thoroughly capable and tried engineer of long experience; and his work, outside of his bureau, as a member of the late Nicaragua Canal Commission, is only another evidence of his excellent training and broad grasp of enterprises of great public importance. As a man he commands the respect of the government officials with whom his duties bring him in contact; and, what is quite as essential in this case, his professional attainments and personal qualities make his appointment a welcome one to every member of the Corps of Civil Engineers of the U. S. Navy. With provision just made for the construction of five new dry-docks for the Navy of the United States, the wise action of Secretary of the Navy Long and of Assistant Secretary Roosevelt is especially timely; and the people of the country now have assurance that the technical work involved in the design and building of these docks will be under the control of an efficient and well-trained Chief. As mentioned in this journal several weeks ago, had this reform in organization been instituted some years ago, the country would not now be badly handicapped by a crippled dry-dock in Brooklyn. We cannot afford to repeat this experience; and the present Navy Department recognizes this fact in the businesslike manner in which it has selected a head for this Bureau with regard to merit and ability alone.

The prospects of war and the rapid increase in the number of our warships in actual commission seem likely to force some immediate action upon the naval personnel bill now before Congress. In any event, steam engineers are to-day badly wanted by the Navy, and they must be obtained from some source outside of the present list of naval officers. Commodore Melville, Chief of the Bureau of Steam Engineering, some time ago recommended the employment of graduates from scientific and technical schools; and properly argued that such graduates were quite as well fitted for duty aboard ship as the engineer cadets who had passed four years at the Naval Academy. We now note that fifteen or more of the graduates in steam engineering from well-known engineering schools in this country have already made formal application to the Navy Department for positions as steam engineers; and many more are available in case the government should call for them. At the same time the House Naval Committee is discussing the Roosevelt bill to reorganize the whole personnel of the U. S. Navy. This committee justly appears to deem it unwise, at this critical period, to attempt any radical upsetting of old and well-recognized duties and responsibilities among the officers of the Navy; and, instead of authorizing the addition of 100 junior engineer officers, called for in that bill, it recommends the enlistment of 100 machinists, ranking as warrant officers, at $1,200 and $1,400 per year.

This recommendation, if carried out, is of especial interest to the young civilian graduates now seeking appointments as engineers in the Navy; and it is well that they should recognize the difference in position aboard the warship between these warrant officers and the proposed junior engineer officers. In the case of the warrant officer, under past conditions, at least, there is no hope of further advance in rank; and it is undoubtedly the intention of the committee, in advising this course, only to enlist among the machinists men of very considerable practical experience in steam engineering. They may not have the technical training and the breadth of special information possessed by the graduate of the scientific schools; but it will be assumed that they have that more valuable possession for the position now to be filled, the actual skill in handling and the intimate acquaintance with marine engines that only long practice can give. In other words, the present want of a sufficient number of skilled and well-trained engineer officers in the Navy to man the ships in commission will place great responsibilities upon these machinists. For these reasons we believe that the appointment of the warrant class of officers would be wise in the present emergency; but, as before stated in this journal, the success of the recommendation will depend solely upon the character and experience of the men enlisted for this service. The experience of the early days of the Civil War is being repeated; when the addition of ships to the Navy far outran the available supply of steam engineers. We then gave these men taken from civil life the rank and commission of "volunteer officers"; whereas we now propose to make them non-commissioned, or warrant officers. The inducement to render service is thus not now as great as it was then; but the supply of available material is also greater at the present time; and men fitted for the duties imposed should be found in sufficient numbers. As the old method gave rise to the "line and staff" controversy that has raged bitterly for over 30 years, a return to it would seem very unadvisable at this time. As to the graduates first referred to, if their training is backed by sufficient practical experience, no better men could be found for this service. But they must enter upon it with the conviction that the sense of a patriotic duty performed for their country in an emergency, will be their chief and immediate reward. Unless the United States Navy should later follow the example of the Army, as it undoubtedly should, and recognize ability and faithful services in the enlisted men by the hope of a commission and rise in rank, once a warrant officer, always a warrant officer.

In the discussion of a paper on "Improved Portland Cement," by Mr. John W. Dickinson, which was presented at the meeting of the Western Society of Engineers on March 16, some interesting remarks were made by Mr. Dankmar Adler, the well-known architect. In referring to the improvements made in the quality of American Portland cement, he stated that while the English and German manufacturers have brought the quality and strength of cement to a very high grade, it seems to be probable that American manufacturers will produce a grade of cement even better than that which has been attained by the careful scientific work of foreign manufacturers. Referring to the composition of concrete, he thought that architects and engineers still too generally follow the proportions which were specified years ago, when the ce-

ments obtainable were decidedly inferior in fineness and strength to those now on the market. It is very commonly specified that concrete is to be composed of 1 part of cement to 3 parts of sand, and then 3 parts of stone to 1 part of this mortar. Mr. Adler thought that 1 part of cement to 4 or even 5 parts of sand would be sufficient, and that 4 or 5 parts of stone might be added to 1 part of cement mortar. The idea thus suggested is already followed out, as far as the sand is concerned, in what is termed sand-cement or silica-cement, which has been described in our columns. This is made from a mixture of sand and ordinary commercial Portland cement, ground together to the fineness of pure cement. This product is then used as cement, and is mixed with sharp sand and broken stone to make concrete. Of course, it is not to be understood that the 1 to 3 to 3 concrete is universally or even mainly used, for though the sand proportion is very generally 3 to 1, yet the stone is often 6 or even 12 to 1. Thus in the concrete work for the Chicago sewers, recently described in our columns, the concrete is to be composed of 1 part cement, 3 parts sand and 9 parts stone, while foundation concrete is to be composed of 1 part cement, 4 parts sand and 12 parts stone. In view of the high grade of the best modern cements, it seems worth while to consider whether, in some cases, the cement is not being used in unnecessary and uneconomical quantities.

THE HEATING VALUE OF SEMI-BITUMINOUS COALS.

The semi-bituminous coals of the United States, including the Clearfield, Pa., the Cumberland, Md., the New River, W. Va., and the Pocahontas, Va., coals, all of which contain from 16 to 22 per cent. of volatile matter are now well known to be the best steam coals available in this country, ranking nearly if not quite as high in heating value as the Welsh coals, which are accepted as the best in Europe. It has become customary, therefore, to use them in boiler testing, especially when a good record for steaming capacity and economy is desired for the boiler. Since it has become customary also to include in reports of steam boiler tests, a statement of the "efficiency" of the boiler, as measured by comparing the heat units absorbed by the boiler per pound of coal or of combustible used with the heating value per pound of such coal or combustible, this heating value being determined by computation from the analysis of a small sample of the coal or by a calorimeter test of a similar small sample, it is highly desirable that our knowledge concerning the heating value of this class of coals be made reasonably definite and accurate.

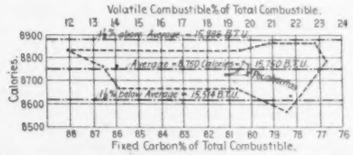
Unfortunately our knowledge of the subject of coal calorimetry is yet in a somewhat chaotic state. The methods of sampling coal are not uniform, and errors in chemical analysis and in calorimetric determinations are so frequent that whenever the heating value of the coal is reported in connection with a boiler test it is apt to be regarded with suspicion. We are led to make these remarks from having seen recently the reports of some boiler tests in which an efficiency of over 80 per cent. was reached, and in which the high figures were apparently obtained by having the heating value of the coal reported as much less than its true value.

For a given actual result in evaporation the lower the heating value of the coal reported by the chemist the higher the apparent efficiency. It is, therefore, to the interest of the boiler maker, if he wishes to obtain a high record for efficiency, that the calorimeter in which the sample of coal is tested should err, if at all, in the direction of showing less than the true heating value of the coal. This is the direction in which a calorimeter is most likely to err, for, assuming that the weighing of the sample burned in the calorimeter is done accurately, that the thermometers are standardized for errors and that they are correctly observed, then an accurate determination will depend (1) upon the complete combustion of every particle of the coal, (2) upon the complete absorption by the water of all the heat in the gases of combustion, and (3) upon the proper correction of the results for radiation. Here are three items of possible error, each of which is apt to cause the apparent heating value of the coal to be less than the true value, and, in a proportional degree, to make the reported "efficiency" of a steam boiler erroneous.

How great the error of a calorimetric test of coal may be, even when the test is made by a skilled and disinterested chemist or testing expert, is indicated by some figures given in the "Draft of Report of the Committee on Boiler Tests," presented at the last meeting of the American Society of Mechanical Engineers. Similar samples of New River, W. Va., coal were sent to three calorimeter experts, one sample to a chemist, and one to some students who were analyzing coal for their thesis work. The heating values reported were as follows:

	B.T.U. per lb. combustible.
Carpenter calorimeter	16,210
Thompson calorimeter	13,799
Barrus calorimeter	15,320
Calculated from analysis, Williams	15,197
Calculated from analysis, students	14,885

We have received some figures of another set of comparative tests from the American Stoker Co., Brooklyn, N. Y., which reveal a like divergence in results obtained by different experimenters from identical samples of Pocahontas coal. During a boiler test made for that company samples of the coal were taken, and at the end of the test were reduced by the usual method of mixing, crushing and quartering, until they were reduced to a small bulk. Identical samples from this bulk were taken and sent to different laboratories for determinations of their heating value. One of the laboratories received two samples with different marks, and reported the two figures 13,069 and 13,956 B. T. U. per lb. of coal. The second laboratory reported 14,421 B. T. U. These three results were all reported as having been obtained by a Barrus calorimeter. A fourth sample was sent to the Ohio State University, and its heating value was there determined by the Mahler calorimeter to be 14,848 B. T. U., and the following analysis was also reported: Fixed carbon, 76.15 per cent.; volatile combustible, 17.20 per cent.; moisture, 0.45 per cent.; ash, 6.20 per cent.


Volatile Combustible% of Total Combustible.
12 13 14 15 16 17 18 19 20 21 22 23 24
Calories.
8900
8800
8700
8600
8500
88 87 86 85 84 83 82 81 80 79 78 77 76
Fixed Carbon% of Total Combustible.

Heating Value of Semi-Bituminous Coals per lb. Combustible (or coal dry and free from ash).

(The field enclosed by the dotted lines covers the range of Mahler's tests of coals, with volatile matter from 12% to 23% of the total combustible. The smaller field encloses the results of 5 tests of Pocahontas coal by Lord and Haas.)

The difference between the lowest and the highest heating value reported is about 12 per cent. of the latter. If the "efficiency" of the boiler, based upon the coal having a heating value of 14,848 B. T. U. was 75 per cent., it would be over 85 per cent. if the lowest heating value, 13,069 B. T. U., were taken. The higher figure, 85 per cent., might be used as an advertisement of the boiler, but it is consistent only with the supposition that the coal is of very ordinary quality, instead of the excellent quality that Pocahontas is usually considered to be.

From the proximate analysis given above, showing a total of fixed carbon and volatile matter of 93.35 per cent., we find that the heating value per unit of combustible is 14,848 ÷ .9335 = 15,907 B. T. U. This is a trifle less than 1 per cent. higher than the average heating value for five samples of Pocahontas coal reported by Professors Lord and Haas in their paper on the "Calorific Value of American Coals," read at the Chicago meeting of the American Institute of Mining Engineers, Feb., 1897 (Eng. News, March 25, 1897). This average value is 8,751 calories = 15,752 B. T. U. There is a remarkable coincidence of this result with the average result of calorimeter tests of semi-bituminous coals from eleven different mines in France reported by Mahler from determinations with his calorimeter (Bulletin de la Societe d'Encouragement pour L'Industrie Nationale, 1892, Rothwell's Mineral Industry, 1892, vol. I., p. 97). His average figure is 8,750 calories = 15,750 B. T. U.

The most important conclusion from the work of Profs. Lord and Haas, viz., that the actual coal (moisture and ash excluded) of a given seam over considerable areas may be regarded as of uniform heating value, is confirmed by a study of Mahler's work. The latter shows, moreover, that there is a remarkable uniformity in the heating value of the combustible portion of the semi-bituminous coals throughout the whole range of their chemical composition as regards their relative percentages of fixed carbon and volatile matter. This is shown in the following table, and also in the diagram plotted therefrom. The percentage of fixed carbon given is that in the combustible, or coal dry and free from ash:

Tests — Mahler — 11 semi-bituminous coals.			Lord and Haas — Pocahontas coal.		
Coal, No.	Fixed carbon, %.	Heating value, calories.	Coal, No.	Fixed carbon, %.	Heating value, calories.
9	85.92	8,656	1	80.10	8,708
10	86.62	8,756	2	81.19	8,731
11	86.00	8,767	3	80.14	8,732
12	88.07	8,834	4	80.61	8,745
13	78.49	8,574	5	80.29	8,777
14	76.77	8,797			
15	80.50	8,839	Average		8,751
16	78.25	8,639	= B. T. U.		15,752
17	77.15	8,867			
18	79.16	8,857			
19	80.71	8,667			
Average		8,750			
= B. T. U.		15,750			

From the diagram enclosing the area covered by Mahler's tests it is seen that the most probable "curve" that can be drawn expressing the relation of the heating power to the composition of these semi-bituminous coals, whose percentage of volatile matter is from 12 to 23 per cent. of the total combustible portion of the coal, is a horizontal straight line through the average value of 8,750 calories, or 15,750 B. T. U., and that lines drawn 1½ per cent. above and 1½ per cent. below this average line enclose 15 out of the 16 tests, the single exception, 8,574 calories, being 2 per cent. below the average.

The results obtained by Mahler and by Lord and Haas agree not only with each other, but also with the heating value calculated by the Dulong formula from the ultimate chemical analysis, the average calculated heating value being less than 1 per cent. greater than that determined by the calorimeter tests.

In view of the close correspondence of the results of these tests with each other, and with the calculated heating values, it would appear that the probable error of the reported "efficiency" of a boiler based upon any single unchecked calorimetric determination of a sample of semi-bituminous coal used in the boiler test is likely to be considerably greater than the error which would ensue if instead of making a calorimetric test the heating value of the combustible portion of the coal is assumed to be 15,750 B. T. U. per lb. That figure is likely to be in error not more than 1½ per cent., which is far within the limits of error of the boiler test itself, of the sampling of the coal, and of a calorimeter test made by any other calorimeter than the Mahler, and even of tests made by that calorimeter in expert hands or without extreme precautions to insure accuracy.

It is safe to assume, in the light of these results, that any calorimetric test of a semi-bituminous coal which shows a heating value of less than 15,500 B. T. U. per unit lb. of combustible is erroneous, and that any reported efficiency of a steam boiler which is based on such low heating value of the coal, is to the same degree in error.

LETTERS TO THE EDITOR.

A Typical Country Bridge Letting.

Sir: The writer recently attended (unofficially) the letting at Rockford, Wright County, Minn., for a bridge across Crow River at that point, the same being a more or less turbulent stream measuring 212 ft. from shore to shore.

Bids were asked for on a barn carpenter's plan, providing for 77 oak piles, each about 28 ft. long, and five spans of oak, each 48 ft. long, the spans to be of the Queen truss type, with packed chords, cast packing blocks, etc., etc., together with pile bent approaches, making length over all of 272 ft. Bids were also tendered for furnishing all material and erecting complete in place a Pratt truss combination bridge 180 ft. clear span,

27 ft. in height c. to c. and 16 ft. clear width, with 32 ft. of wooden approach at each end. The iron or steel work to be donated to Wright Co. by Hennepin Co. if they chose to use it in the combination bridge. The lowest bid on the all wooden bridge or trestle was $1,525, by a local bidder, to whom the contract was promptly awarded. The lowest bid for the combination bridge and approaches complete was $1,635. That is to say, the board concluded that it was better to have five all wooden spans, with four wooden piers in the body of the stream to catch ice, etc. (within two years there has been a flood that to a greater or less extent paralyzed all the dams and most of the bridges on the river, some five or six in number), than to have one clear span of 180 ft., with only two piers in the stream, and they so near to the shore as to be easily protected. There is no question as to the honesty of the Board, but in this case, as in a thousand others, they simply made a colossal mistake. A. T. E.

Minneapolis, Minn., Feb. 25, 1898.

The Municipalities Included in the Metropolitan Water District, Boston and Vicinity.

Sir: In your note of March 17, relating to the turning of the water into the Nashua Aqueduct, you have stated that "twelve cities and towns are all the municipalities yet actually included within the Metropolitan Water District, but the act forming the district provides for including 16 more."

The Metropolitan Water Act provides for supplying 13 cities and towns, of which nine are at present supplied from our works, either wholly or in part. Of the four remaining cities and towns, two, Belmont and Watertown, will be supplied before the close of the present season, together with Quincy, which has been added to the district since the act was passed. The city of Newton has an ample supply for the present, and the town of Hyde Park has not as yet made formal application to be supplied. Very truly yours,

Dexter Brackett,
Engineer, Distribution Department
Metropolitan Water Board.

3 Mt. Vernon St., Boston, Mass., March 21, 1898.

(Our misstatement arose from the fact that the original plans of the State Board of Health contemplated that water should be provided for 28 cities and towns, although certain of these were not to be compelled to come into the district against their will. The act, as passed, limited the number of municipalities to 13, as Mr. Brackett stated, but it also provides that the board shall, "on application, admit any other city or town, any part of which is within ten miles of the state house." It also appears from the act that the municipalities named in the act must make formal application to the board before they can secure water from the Metropolitan System.—Ed.)

Criticisms on Recent Action by the American Society of Civil Engineers.

Sir: Interfering engagements prevented me, an older Member of the American Society of Civil Engineers, from being present at the late annual meeting except for so brief a time as would justify entry of my name as attending. A copy of the Proceedings for February, 1898, recently reached me, in which is a formal record of what was discussed and determined at the principal annual conference of this predominating association of American Engineers. Permit me to comment on the Proceedings as there recorded:

In the beginning it is to be said, that whatever criticism is herein included, is upon the methods observed and not upon the worthy men, who as officials of the Society, Treasurer, Secretary, and others, have and continue to serve it at personal loss, with wise judgment and the highest purposes; no others could do better, under the existing circumstances, and the Society is fortunate in being served by them.

First: Referring to discussion upon the acceptance of the Treasurer's and the Auditor's reports of expenditures during the year then closed—Members, accustomed by long years of experience, to scrutinize and approve large payments under their direction, exhibited by their questions, an inability to understand and reconcile certain items of the former, but none seemed to doubt the propriety of the latter. The Constitution of the Society (Article VI., Sec. 4), prescribing the duties of the Secretary, states:

He shall see that all moneys due the Society are carefully collected, and without loss transferred to the custody of the Treasurer.

He shall carefully scrutinize all expenditures, and use his best endeavor to secure economy in the administration of the Society.

He shall personally certify the accuracy of all bills or vouchers on which money is to be paid, and shall countersign the checks drawn by the Treasurer against the funds of the Society, when such drafts are known to him to be proper and duly authorized by the Board of Direction.

And in Sec. 6, it states:

An Auditor shall be appointed by the Board of Direction, who shall have entire charge of the books of account of the Society, and shall furnish monthly to the Board of Direction a statement of receipts and expenses under their several headings, and also a statement of monthly balances.

He shall present annually to the Board of Direction a balance sheet of his books, as of the 31st of December, and shall furnish from time to time other statements as may be required of him.

It is well known that the latter section was introduced by one of the compilers of the present Constitution, who for many years had held positions, during which large and diverse expenditures were subject to his direction, and for which he, in a large measure, was responsible; and it was approved by his associate compilers, some of whom had held similar positions of responsibility. Its intent was, and is, that the Auditor should be an independent official, having nought to do with the expenditure of the Society's moneys, but simply to examine and approve the record of such expenditures.

Instead, this year and last, an official as Secretary has had in the discharge of his duties to direct and certify to whatever expenditures were made, and then, as Auditor, approve, if he may, his, the Secretary's, action. In this case, can the left hand not know what the right hand doeth? Of all men, professional men more than others, and Engineers above all, should obey law, particularly law by themselves enacted.

Second: Upon discussion of the following:

That a special committee be appointed under the rules of the Society to examine into the question of paints used for structural work in engineering. * * *

it appeared that members of long experience were in doubt whether the aggregate wisdom of the Society "as a body" could cope with this "intricate and unsolved" matter, since they some time individually had been deceived and led astray by hypnotic salesmen, whose wares were "clay" and otherwise. Doubtless these members candidly spoke for themselves; but because they in their innocence were deceived, was that a reason why the Society in its mighty aggregate wisdom should not make exhaustive and determinate investigation which would, perhaps for all time, strengthen their weakness; or, was it apprehended that an engineer who designed and built a structure, was unable to decide what was the better paint to be applied for preservation, and may be for decoration. In brief, was this a matter too great for the Am. Soc. C. E. in membership, single and collective, to establish; and if so, who of the body would thus advertise the incompetency.

Third: There was discussion as to whether the Society should continue the exclusive use of the 24 hours per day notation, in which it appeared that the absurd practice began and has been followed until now, without recorded authority, although perhaps not five of the entire membership present, themselves observed, or could, without arithmetical process apply it. Since the practice existed, a majority voted that it should continue to be.

Fourth: In opposing this resolution, "That the American Society of Civil Engineers place itself on record as favoring judicial legal restrictions against the unauthorized and improper use of the title 'Civil Engineer,' one leading member said that the resolution 'expresses an opinion and commits this Society to an opinion.' * * * And it has always been ruled 'that no member and no number of members has a right to commit the society to an opinion.'" This is regardless of the fact that the engineer has not only to found his design upon opinion, but afterward in construction and operation, to risk his work and success upon that opinion. Another leading member objected, because the only certificate he had, permitted him to practice law, which he would not. That is, because in his adolescent days, he deemed an authorization necessary for practice in one profession, and for which he had fitted himself, in his riper years, he was certain that no such authorization should be required for practice in another profession for which he had not been previously or similarly trained. Such is logic. These and similar statements caused the resolution to be tabled.

The quotations upon which the above is based, are from an official record, whether fair or not may be readily determined; the criticisms made are my own, to stand or fall as they have merit. In conclusion, the following question is asked: Is, or is not the man of affairs, keen and alert to recognize both the conditions which are to be met and overcome, and the quality of the agents he may employ successfully to accomplish his purpose, justified in regarding the engineer employed simply as a workman, one of the many whose daily effort tends to perfect the general plan; or should the engineer, this agent of his employer, claim and rank as master? The future decision of this question and its final acceptance rest with the engineers themselves; singly perhaps, but if associated and persistent, surely with them.

Brooklyn, March 12, 1898. G. Leverich.

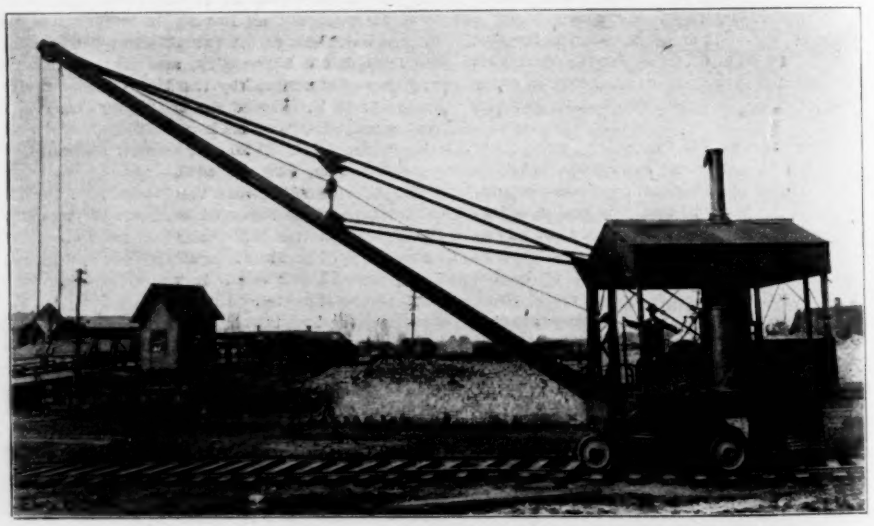
Notes and Queries.

A. D. S. asks: Can you inform us if there is any published rule for estimating the amount of paint necessary in painting iron bridges, which is reliable?

We would refer to a table published in our issue of Feb. 6, 1896.

TRAVELING CRANE WITH FIXED BOOM.

A traveling crane of novel design is being used on the construction of the new sewerage system at New Orleans, La., and this machine is shown in the accompanying cut. One special feature of the design is that the boom has a fixed radius and cannot be raised and lowered. The main member of the boom is built up of channels, connected by tie-rods and diagonal bracing, while the rigid guys and braces are of angle iron. The racer and the truck are each formed of one large casting, thus making a very rigid machine. All the motions are controlled by friction clutches. In operation, the machine travels on a track of 8-ft. gage, parallel to the trench, delivering the sewer material as well as removing the earth excavated. The boom has a reach of 40 ft. from the center of the track, while the machine has a hoisting capacity of three tons, and by means of bevel gearing can travel along the track at a speed of 350 ft. per minute. The machine was designed and built by the American Hoist & Derrick Co., of St. Paul, Minn., and we are indebted to the builders for photographs and information. The company is about to build similar machines of various sizes with hoisting capacities of 3 to 15 tons.



LOCOMOTIVE CRANE WITH FIXED BOOM.
American Hoist & Derrick Co., Builders.

An interesting application of steam cranes to logging work is the use of a somewhat similar machine to the above, with shorter and steeper

boom and greater hoisting capacity, built by the same company for loading logs on to railway cars in the pine woods of Wisconsin. The crane runs on a track of 7 ft. 6 ins. gage laid on the flat cars of the train, and backs down along the train as each car is loaded. The track is made in sections, and when the crane has finished a load it backs up to the rear of the car, picks up the section it formerly stood on and replaces this section behind it, on the next car. The crane can handle logs up to 35 ft. in length, and can readily load 25 cars per day, including all changes and moves. Four men only are required, an engineman and fireman on the crane, and two men to place the logs. The machine has a hoisting capacity of 5 tons, and its boom has a reach of 20 ft. from the center of the track, while the top of the boom is 25 ft. above the floor of the flat car.

THE HEMET DAM, CALIFORNIA.

An arched masonry dam 122½ ft. high above the creek bed and 246 ft. long at its crest, was built in Riverside Co., Cal., in 1891 to 1895, by the Lake Hemet Water Co. to store water for irrigation. In our issue of Jan. 30, 1892, we published a brief description of the structure, without illustrations. We now give a plan, profile and cross section of the dam and a few facts regarding it.*

The drainage area above the dam is not known, being estimated at from 65 to 150 sq. miles of mountainous country. The outlet from the Hemet Valley is a narrow granite canyon with a fall of about 2,000 ft. in nine miles to the point where a timber diverting weir has been built for the distributing system of the irrigation works below.

When the dam was first discussed, in 1886, it was proposed to make it of the ultra-curved type, with the shortest possible radius and a thickness of only 4 ft., from bottom to top. The original company did not approve so radical a design and after a reorganization the company utilized what water it could without storage works. A rock-fill dam was discussed and the idea abandoned.

The present structure was designed by Mr. Schuyler and he was consulting engineer to the company during its construction.

Progress on the dam is shown by the dates at the right of the section, Fig. 2. Work was suspended for four months, from Jan. 24, 1892, and from Jan. 9, 1893, to the fall of 1895. The dimensions of the structure are fully given in the illustrations.

The dam was built of uncoursed rough granite rubble, laid in Portland cement concrete, with the facings in cement mortar. The facing stones were roughly scabbled. The total contents of the structure are 31,105 cu. yds., for which about 20,000 bbls. of cement were used at a cost of about $5 per bbl., delivered. The cement had to be hauled 23 miles over steep grades. The teams hauled wood and timber on the return trips.

All the stone was quarried within 400 ft. of the dam, on both sides of the canyon, above and below. It was conveyed to place by two cableways, each about 800 ft. long and of 1½-in. wire cables. Derricks were used on the dams for swinging stone to place, being operated with power from a 3-ft. Pelton wheel.

Mr. Schuyler describes the means employed for securing and delivering the sand as follows:

> The sand used was clean and sharp, and was accumulated constantly, as it was rolled along the bottom of the flowing stream, by a temporary log-dam reservoir, whence it was periodically discharged into a sandbox below by opening sluice gates. From the sandbox it was conveyed to the mixing platform by an endless wire rope carrying triangular buckets of sheet-iron, holding about a quart each, and placed at intervals of 20 ft. along the double wire rope, which passed over drums in the sandbox below and on the platform above. The wire ropes were about 12 ins. apart. The hoist was about 125 ft. and the horizontal distance over which it was conveyed was 350 to 400 ft. This device was operated by the same engine which propelled the rock crusher and concrete mixer. It was almost automatic in its operation and gave very little trouble, delivering the sand thoroughly washed in the quantity desired, and emptying it into bins, where the exact charge for a mixing was accurately gaged.

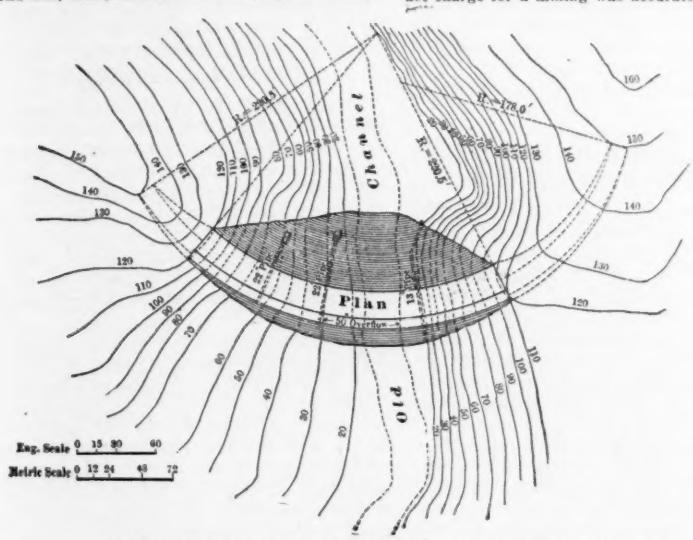


FIG. 1.—PLAN OF HEMET DAM, RIVERSIDE COUNTY, CAL.
Jas. D. Schuyler, M. Am. Soc. C. E., Los Angeles, Engineer.

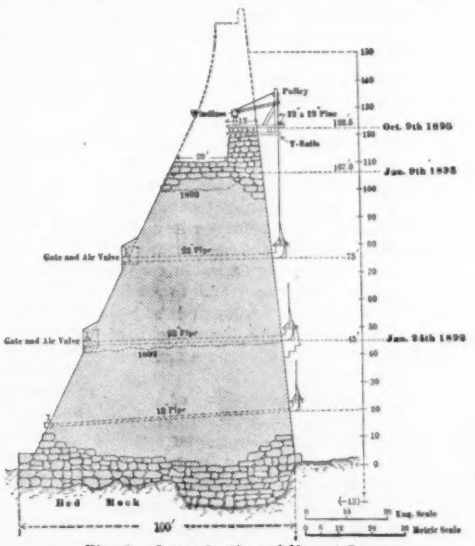


Fig. 3.—Cross-Section of Hemet Dam.

The concrete used for embedding the blocks was of 1 part cement, 3 of sand, 6 of stone, the latter crushed to pass through a 2½-in. ring. All mortar and concrete were mixed by machinery. Most of the masonry work was done by laborers paid $1.75 per day. Masons were employed only on the facings, and received $3 to $3.50 per day. Mr. Schuyler was not at liberty to give further figures of cost, except that "under favorable conditions some of the masonry was put in for as low as $4 per cu. yd."

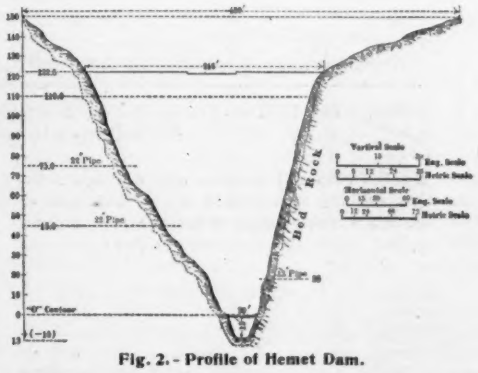


Fig. 2.—Profile of Hemet Dam.

The two 22-in. outlet pipes, passing through the dam, are of 11-32-in. lap-welded wrought iron, with flange joints. The 13-in. outlet pipe was used to supply the Pelton wheel, mentioned above.

No cracks have appeared in the dam. Regarding leakage Mr. Schuyler says:

> Considerable leakage occurred through the masonry prior to the fall of 1894, when the water was drawn down and the entire face of the wall was carefully repointed. This resulted in materially lessening the leaks, so that they now are reduced to a mere sweating in patches here and there over the lower face, and the total leakage in the spring of 1897, with the gage at 101.5 ft., measured but 1,200 cu. ft. per day.

The profile of the dam is of the gravity type, with the line of pressure, when the reservoir is full, just outside the inner third of the base at all points. As shown by the dotted line, on Fig. 3, the dam may be carried higher in the future, but this will necessitate the building of another dam to prevent overflow along a low stretch in the ridge.

Mr. Schuyler states that he

> has always favored the arched form for all masonry dams as a measure of stability or as a factor of safety against all possible contingencies, even though their gravity be sufficient to render them entirely stable to resist water pressure.

He cites some arguments by Professor Forchheimer, of Aix-la-Chapelle, in support of this position,* who gives a number of instances where straight dams have moved and cracked, due to differences in temperature. In curved dams, the professor says, this would be impossible.

The capacity of the Hemet reservoir at its present level is 3,430,000,000 gallons, or 10,500 acre-ft. If the dam were carried to the 150-ft. contour its capacity would be increased nearly 2½ times, and if raised to 160 ft., more than three-fold.

*From a pretty complete paper on the dam by Mr. Jas. D. Schuyler, M. Am. Soc. C. E., read before the Technical Society of the Pacific Coast and published in the "Journal of the Association of Engineering Societies" for September, 1897.

THE HIGH EXPLOSIVES USED IN NAVAL WARFARE.

In connection with the destruction of the U. S. Battleship "Maine" in the harbor of Havana, there has been much newspaper discussion regarding the nature of the high explosives carried in the magazines of modern warships, especially those used for charging explosive shells. As much of the information thus given in the daily press has been misleading, some remarks upon the different forms of these explosives and their power and safety may be timely.

Since the introduction of the French melinite, in 1885, as a substitute for black powder in the bursting charge of shells, other nations have been experimenting in the same direction, and now England, Germany and the United States claim to have found explosives equally powerful and much safer than the melinite originally invented by M. Turpin. The secret of the French composition was very carefully guarded for a number of years, and even now the exact method of manufacture has to be guessed at. But competent authorities say that there is very little doubt that it is essentially a mixture of fused picric acid and tri-nitro-cellulose or gun-cotton, dissolved in a mixture of ether and alcohol. The ether-alcohol mixture evaporates and the resulting cake is granulated. Melinite has the characteristic yellow color of picric acid, has a bitter taste and is practically without crystals. When ignited by a flame or by a heated wire in an unconfined state, it gives off a reddish yellow flame and copious volumes of black smoke.

*Proc. Inst. C. E., Vol. cxv., p. 156, in discussion on a series of papers on "Impounding Reservoirs."

Lyddite, used by the English government as an explosive charge in shells, is undoubtedly a picric acid compound and is said to be identical with melinite, in its improved form; and the Joveite employed to some extent in filling shells by the United States government has the same characteristic yellow appearance and bitter taste and would seem to be practically the same explosive. In any event, and as the result of long and intelligent experiment this picric compound seems to be the only high explosive that can be safely and conveniently used in our modern high-power guns. Wet gun-cotton is perhaps safer for this purpose; but as it is made in disks and has to be packed into the shell by hand, its use would necessitate a shell made in two sections, screwed together, and this shell would thus be structurally weak as compared with a solid armor-piercing projectile.

The conditions to be filled by a satisfactory explosive of this nature are severe. The compound must be safe to manufacture, store and transport; and, above all, it must be stable in its composition under all conditions of climate, position in the ship and actual service. It must also withstand the shock of discharge from high-power guns, delivering a projectile with a muzzle velocity of 2,000 ft. per second, or more; it must not explode when accidentally struck by other shells; yet it must detonate violently when it strikes the decks or lightly armored parts of an enemy and do this without the intervention of any dangerous fulminates.

In English experience Lyddite has been found to be a stable compound, safe to manufacture, store and transport. And while some accidents have occurred during the firing of shells charged with this compound, in nearly all cases the cause has been traced to faults in the shell, and not to oversensitiveness in the Lyddite. The English shells now used are, like our own, made from the best forged steel, and the chances of premature explosion are thus decreased.

Gun-cotton, used for the "war-heads" of automobile torpedoes, is made of cotton waste or cellulose, subjected to a bath of one part of nitric acid and three parts of sulphuric acid, under special and elaborate conditions of treatment. The resulting product is first molded into blocks and then compressed, under a hydraulic pressure of over 6,000 lbs. to the sq. in., into disks 2.9 ins. diameter, and 2 ins. high, with the corners of the disk chamfered. As these disks come from the press they contain from 12 to 16% of water; but before being sent away for storage, they are soaked in fresh water until they contain about 30 to 35%. In this condition it is stored in shellacked boxes and is practically inexplosive; but the saturation must be constantly kept up to this percentage during storage. The so-called primer disks are only half the thickness of the other disks and contain a central hole for the insertion of the detonator. When these primer disks are wanted for use they are dried by being hung in the air for some time on a brass rod or on a cord. The detonation of about one pound of the dry disks will explode gun-cotton containing 30% of water, and the velocity of transmission of detonation through continuous slabs of gun-cotton is very rapid, ranging from 17,000 to 20,000 ft. per second.

But the wet gun-cotton alone is not affected by shock; it will not explode when penetrated by rifle bullets; is comparatively insensible to sympathetic explosion, and is not exploded by heat. To test this last-named quality the British government, some years ago, burned up in bonfires two lots of gun-cotton, of one ton each, but containing 30% of water. In one case the disks were in a closed tank, and in the other in 80 closed packages. But in both cases the gun-cotton burned away without explosion. Under shock from the proper kind and weight of detonation, the explosive properties of gun-cotton are unaffected by water; but when dry it is more liable to detonation from influences. On board ship this gun-cotton is stored in a separate and special magazine, isolated from all other powders and detonators.

The smokeless powder, developed at the U. S. Naval Torpedo Station and intended for use in guns of all calibers in the U. S. Navy, is essentially a nitro-cellulose powder. It is made of a mixture of soluble and insoluble nitro-cellulose, to which is added about 19% of nitrates of barium and potassium and a very small percentage of calcium carbonate. As yet it is only made for the rapid-fire guns up to 6-in. caliber, and the resultant powder takes the form of compressed scored sheets or ribbons; in thickness equalling 0.015 of the caliber of the gun and of a length made to fit the powder chamber of the gun. These sheets have a yellowish-gray color, with a smooth surface and glue-like consistency. Nitro-cellulose is the resultant of the treatment of cotton fiber with nitric acid, and is only another form of gun-cotton, whch latter is a hexanitrate of cellulose.

The Brown Prismatic, or cocoa powder, used in our navy for the heavier guns, is an explosive of the old type, inasmuch as it is made of a compound of niter, charcoal and sulphur. But the method of manufacture is very different and imparts to it qualities not possessed by the old black powder. This new powder is in the form of perforated hexagonal prisms, weighing about eleven to the pound for large guns, of the color of cocoa, and the velocity of combustion is so low that a grain may be ignited when held in the hand and then placed on the ground before the burning part reaches the fingers. Its advantages are, the ability to impart a high initial velocity to the projectile without exerting an undue pressure upon the gun, and the form, size and great density of the grains.

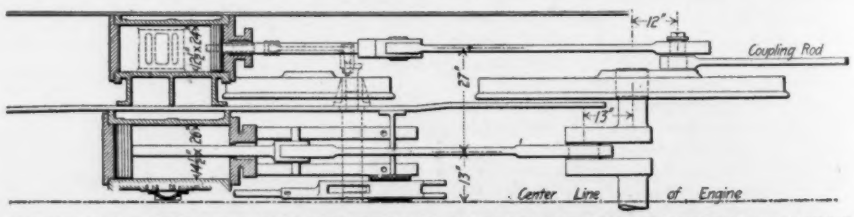
FOUR-CYLINDER LOCOMOTIVE FOR THE GLASGOW & SOUTHWESTERN RY.

In a recent issue we referred to the experimental use of four-cylinder simple and compound locomotives on two British railways, and we are now enabled to describe a four-cylinder simple locomotive on the Glasgow & Southwestern Ry., for particulars of which we are indebted to Mr. James Manson, Locomotive Superintendent of that road. The engine is a handsome express passenger locomotive of the eight-wheel type, and was built at the railway company's works at Kilmarnock, Scotland.

The four cylinders are placed side by side. Two are inside the frames, driving a crank axle on the ordinary plan of English inside cylinder engines. The other two are outside the frames, with the connecting rods attached to crank pins in the wheels on the crank axle. The outside cranks are arranged opposite to the inside cranks, as shown, so that the reciprocating masses balance each other. The rear axle is driven by coupling rods. The accompanying cut shows a plan of part of the engine. From this it will be seen that the valves for the inside cylinders are placed between these cylinders and worked direct from the link motion. The outside cylinders have balanced valves (with a relief ring or piston on top) and are actuated by a rocking shaft, so that only two sets of valve gear are required to work the four valves. The leading dimensions of the engine are as follows:

Dimensions of Four-Cylinder Simple Locomotive.

Running Gear:	
Driving wheels (4), diameter	6 ft. 9½ ins.
Truck wheels (4), diameter	3 " 7½ "
Tender wheels (6), diameter	3 " 10½ "
Engine truck	Swing center.
Journals, driving axles	7½ × 8 ins.
Wheelbase.—Driving	8 ft. 9 "
Truck	6 " 10 "
Total engine	21 " 11 "
Tender	12 " 0 "
Engine and tender	42 " 6 "
Engine truck-pin to c. leading driving wheel	10 " 2 "
Weight in Working Order:	
On driving wheels	71,000 lbs.
On truck wheels	38,080 "
Engine, total	109,080 "
Tender, empty	36,064 "
Tender, loaded	72,240 "
Water in tank	25,000 "
Coal on tender	11,200 "
Cylinders.—Number	Four.
Diameter and stroke of inside	20 ins.
Diameter and stroke of outside	24 "
Boiler.—Type	[illegible] top.
Diameter of barrel inside	[illegible] ins.
Thickness, barrel plates	½-in.
Thickness, smokebox tube-plate	⅝-in.
Height from rail to center line	[illegible] ins.
Working steam pressure	6 lbs.
Firebox.—Type	Flat top, with [illegible] stays.
Length, inside	[illegible] ins.
Width, inside	[illegible] "
Depth at front	[illegible] "
At back	[illegible] "
Thickness, side plates	½-in.
Back plates	½-in.
Crown plate	½-in.
Tube plate	½-in.
Stay bolts	diameter, 1 in.; [illegible] ½-in.
Tubes.—Material	Brass; No. 238
Pitch	[illegible] ins.
Diameter, outside	1⅞ "
Length between tube plates	[illegible] "
Heating Surface and Grate Area:	
Heating surface, tubes (exterior area)	[illegible] sq. ft.
Firebox	[illegible] "
Total	[illegible] "
Grate area	[illegible] "
Ratio of total heating surface to grate area	[illegible] to 1
Miscellaneous:	
Exhaust nozzle, diameter	4½ ins.
Smokestack, height from rail to top	13 ft.
Capacity of tender tank	[illegible] gallons.
Of coal space	[illegible] lbs.
Brake fittings	Automatic vacuum.



HORIZONTAL SECTION THROUGH CYLINDERS OF GLASGOW AND SOUTHWESTERN LOCOMOTIVE.
James Manson, Locomotive Superintendent.

THE SEPARATE HIGH-PRESSURE FIRE SERVICE SYSTEM AT PROVIDENCE, R. I.

Providence, R. I., has generally been supposed, on account of the large size of its water distribution pipe, and the abundance of its water supply, to be well protected against fire. An independent high-pressure fire service system, however, has been recently installed there, consisting of very large pipe, which is not to be used for any purpose but fire protection, and no connections of any kind, whatever, except those of the hydrants of the service, are connected to the pipe of the system.

The average static pressure in the mains of the new fire service system is about 44 lbs. more than it is in the pipes of the low service at the same elevations.

The high-pressure fire service system was completed last October, and it seems to give great satisfaction to all concerned. The insurance rates have been considerably reduced within the district which it protects, and it was demonstrated at a large fire last December (in the opinion of the fire commissioners and others) that it practically paid for itself during this fire, as the conflagration was kept within the walls of the building in which it originated, by the aid of the new fire service; otherwise it might have spread over a large area and caused a great additional loss of property.

The area of the new fire service district, which is principally located in the center of the business portion of the city, is about ½-sq. mile. The supply of water is taken from the 24-in. main leading from the Fruit Hill high service reservoir, at a point a little more than three miles from the reservoir, the water line of which is 274.75 ft. above datum.

The total length of the pipe of the high pressure fire system is 29,409 ft., namely: 4,189 ft. of 24-in. pipe; 23,004 ft. of 16-in. pipe; and 2,216 ft. of 12-in. pipe. To this pipe are connected 89 hydrants.

The static pressure at the hydrants ranges from 116 to 85 lbs. per sq. in., according to the location of the hydrants. The pipe is of such large size that under ordinary conditions the pressure will not fall below 100 lbs. per sq. in. in the center of the business portion of the city when an average rate of 5,000,000 gallons per 24 hours, or 3,472 gallons per minute, is being drawn from the pipe. Arrangements have also been made so that in the future, if it should be desired, a stationary pumping plant can be connected to the pipe of

the fire system and the pressure raised 50 lbs. more per sq. in. than the pressure is at the present time.

At a test in the center of the business portion of the city, soon after the system was completed, a stream of water was discharged from a 2½-in.

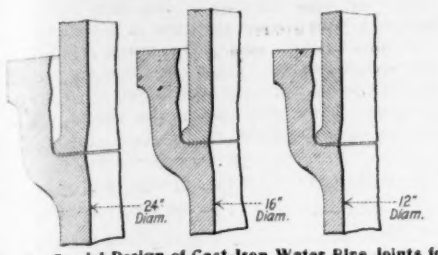


Fig. 2.—Special Design of Cast-Iron Water Pipe Joints for High Pressure Fire Service.

ring nozzle to a vertical height of about 137 ft., while the water was flowing at the rate of about 950 gallons per minute.

The total cost of the system was about $139,749, or about $4.75 per lin. ft. The pipe was laid 6.25 ft. deep, which is about 1.6 ft. deeper than the depth of the ordinary water pipe, in order to pass under the water pipe and other obstructions that were already in the ground as well as a precaution against the freezing of the water in the pipe of the fire system, which would be more likely to occur on account of its comparative stagnation. As an additional safeguard against freezing, a by-pass has been located between the fire service system and the low service, and three blow-offs are connected at convenient points.

For more than four months during the past winter, the gate of the by-pass into the low service has been opened a few times, allowing a discharge of about 40,000 gallons per 24 hours into the low service, and every morning, during the same period, two blow-offs have been opened about 15 minutes, allowing a discharge of about 1,100 gallons in addition to that passing through the by-pass. The circulation in the fire system produced by these discharges has prevented the minimum temperature of the water from falling below 37° during the winter.

The expense of laying the pipe was considerable on account of its being principally laid in paved or macadamized streets, on account of its unusual depth, which necessitated generally the sheeting of the trench in which the pipe was laid; and in some cases very bad quicksand was encountered, which necessitated the dumping of coarse gravel into the bottom of the trench in order to secure a satisfactory foundation for the pipe.

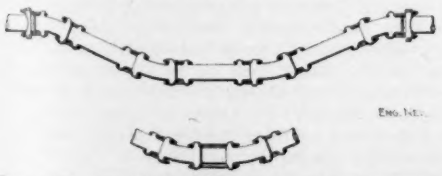


Fig. 3.—Manner of Securing Curved Pipe for High Pressure Fire Service.

Fig. 1 shows the pipe as laid in the high-pressure fire service district and the hydrants connected to the pipe. As will be seen by the plan, the static pressure at 80% of the hydrants is more than 100 lbs. This plan does not show, however, the pipes and hydrants of the low service, which are laid in all of the streets shown upon the plan. Fig. 2 shows a section of the pipe joints, which have a double groove for increasing the resistance of the lead which was used for calking the joints. These joints were especially designed for the fire service pipe. Fig. 3 shows the method followed in securing the curved pipe of the system having an angle of more than 10°. As will be seen from the plan, collars, lugs and screw bolts were used. This method of securing the curved pipe, which was also especially designed for the fire service system, has given great satisfaction, both on account of the quickness with which the work could be done and the security of the same after it was completed.

It should be remembered, as has already been mentioned, that in designing and doing the work a much larger increase of pressure was anticipated in the future. An increase of pressure, however, is not probable, for at least some time to come, as the pressure at the present time is eminently satisfactory to the fire department.

FIG. 1.—PLAN OF SEPARATE HIGH PRESSURE FIRE SERVICE SYSTEM AT PROVIDENCE, R. I.

Edmund B. Weston, M. Am. Soc. C. E., Engineer in Charge Providence Water Department.

The special designs mentioned above for the system were made under the personal direction of Mr. Edmund B. Weston, M. Am. Soc. C. E., Engineer in charge of the Providence Water Department, who also directed the construction work. The loss of head due to the friction of the water flowing in the pipe, which was based upon what it will be after ten years of service, was computed by a new formula, dependent upon the age of the pipe, which was constructed by Mr. Weston. We are indebted to Mr. Weston for the above information.

NOTES FROM AMERICAN BRIDGE SHOPS.

II.

New Jersey Steel & Iron Co., Trenton, N. J.—When in 1845 Mr. Abram S. Hewitt built the first mill for rolling iron at these works he also erected a large wooden house only a few minutes' walk from his business. This old mansion has been inherited by the engineering department and now houses its offices and drafting rooms. The somewhat unusual practice is adopted here of drawing upon the clerical force for draftsmen. Bright young fellows in the counting room who show some aptitude for drafting and mathematics are taken into the drawing room and trained in drafting and detailing, and in fact pushed up the ladder as far as their abilities will warrant. It has been found that men obtained in this manner are more likely to remain permanently with the company than are graduates taken on from the technical schools, who naturally look upon their drafting room experience only as a probation for better things and hasten to abandon their positions as soon as this end has been obtained.

So far as is practicable the departments of estimating, designing and drafting are kept separate, each department having an organization and offices of its own. All drawings are traced on standard sheets 2 ft. wide and 3 ft. long. While in use, the tracings are kept filed flat in cases of drawers in the drawing room, but they are permanently filed in locked cases of pigeon holes. These pigeon holes are approximately 9 ins. high, 12 ins. wide, and 2 ft. deep, and in each is filed as many sets of drawings rolled separately as it will comfortably hold. Each set of drawings is rolled and wrapped in brown paper and has a tag giving its number and some other information attached to one end. These rolls are put into the pigeon holes with their tagged ends outermost. As already stated, the cases are locked, and to obtain a drawing application is made to the person having charge of the keys, who gets the drawing and removes the tag, which is filed in his desk attached to a card giving the name of the borrower. A record is thus had of the whereabouts of every drawing, whether in the filing case or in the hands of some of the draftsmen or engineers. A complete index is kept of all drawings, which shows their location in the filing case. It was said that drawings were seldom lost or mislaid, and that in all respects the system had proved satisfactory for practical working conditions, although it was far from being as elaborate a system as many firms deemed advisable.

These works, unlike many which formerly rolled wrought iron, did not change to the manufacture of steel when that material usurped the place of iron for structural work, and they therefore have a large iron rolling mill and its accessories standing idle. The bridge works thus go to the general market for their material. The machinery in the truss shop is operated by shafting, except in the case of some of the new machine tools, which are run by electric motors. It is the intention of the company to fit all new machines with motors, and in this manner to replace ultimately the present line shafting with electric power. Compresed air is used quite extensively for riveting, chipping and other purposes. A milling machine for finishing the ends of angle stiffeners, much like the one used at the Elmira Bridge Co.'s works (Eng. News, March 3), except that the cutters are vertical instead of horizontal, was noticed among the smaller tools. Perhaps the most noteworthy tool, however, was a stationary hydraulic riveter capable of driving all the rivets in a girder 10 ft. deep and 125 ft. long. The riveter is set vertical at the middle of a pit 250 ft. long and three or four feet wide, one jaw on each side. A trackway for trolleys runs the full length of the pit overhead and carries a special system of hoisting trolleys, which raise and lower the girder and move it lengthwise of the pit, thus making all parts accessible to the riveter. This machine has proved very convenient for riveting up girders which are to be shipped complete.

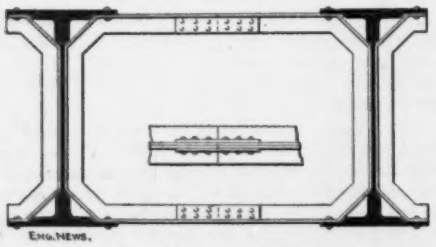
In the template and machine shops work was in active progress on the steel work for the anchorages of the New East River Bridge (Eng. News, Sept. 9, 1897). A finished pattern for one of the anchor chain plates, 4 ft. 1½ ins. × 10 ft. × 2 ft. 8½ ins. high, gave a very good idea of the size and weight of these cast steel members. Several of the anchor chain pins of open-hearth acid steel were also seen in the rough and partly finished states. These pins are all between 6 ft. and 7 ft. long, varying somewhat between these limits, 6 15-16 ins. in diameter, and are to have a hole 1½ ins. in diameter bored through their centers. At the time of the writer's visit the engineers were figuring upon a plan for boring these holes, but had not decided definitely upon the best. The rough forgings for these pins, which were made by the Pennsylvania Steel Co., were notable for their straight and smooth appearance. The total amount of steel work in the two anchorages, for which this company has the contract, is about 3,000 tons.

John A. Roebling's Sons Co., Trenton, N. J.—Although bridge work is among the least important branches of this firm's activity, yet the worthy position which both the elder John A. Roebling and his son, W. A. Roebling, occupy in the annals of bridge engineering in America seems to make it quite proper to schedule the firm among American bridge works. As is well known, the business of the firm is the manufacture of wire and the products of wire, such as cables, wire lath,

wire cloth, and insulated and armored wire for electric work and various other branches. Its plant occupies an area of about 25 acres and a force of 2,500 persons is employed. Special machines are used almost exclusively in the manufacture.

Coming to the works in the form of ingots, the material is first put through the bar mill, where it is rolled into bars of varying sizes depending upon the purpose for which it will be used. The product of the bar mill, although it may be no larger than a small lead pencil and coiled onto reels, is called a "bar" until it has been drawn. These coils of bars are next subjected to a cleaning process to remove the rust and scale which soon cut out the dies if allowed to remain. This cleaning process consists of dipping the bars successively into vats of acid, water and lime-water. After cleaning the bars are ready to be drawn, which consists simply in pulling the metal through dies of constantly diminishing size, the process of course stopping at the die producing wire of the requisite diameter. In its general features the process is very simple and exactly the same for all ordinary kinds of wire, but a multitude of modifications are adopted to produce wires of especial qualities and finish. For example, steel wire of very high tensile strength has to be drawn through the dies more slowly than ordinary quality wire, to be more carefully lubricated, and to be annealed at least once during the drawing process. In fact the whole secret of producing the quality and finish, especially of the finer wire, lies in the multiplication and combination of these minor details of lubrication, etc. Different processes are also adopted for manipulating wire drawn from copper and other metals or alloys.

As a rule, the processes of twisting the wire into cables and of braiding and covering it are almost as simple in their general features as are the processes of rolling and drawing. Most of the machines used in these finishing processes are modifications of the machine used for twisting wire rope, such as is used for hoisting purposes, cableways, etc. This machine consists of a circular disk, at the center of which is erected a perpendicular shaft carrying at its end a "head." The plane of the disk may be either horizontal or vertical. Around the edge of the disk are spaced a number of bobbins, or spools, full of wire, the number of spools used depending upon the number of wires in the final rope. The free end of the wire from each spool is carried to the head where, by a revolving motion of the disk, they are twisted together. As fast as twisted the rope is wound onto a drum. Where the rope is to consist of a number of strands, say six, with seven wires in each strand, each spool is replaced by a small disk and head, similar to the main apparatus. Each small disk and head twists a strand of seven wires and the six strands run to the "head" of the main shaft and are there twisted into the final rope, just as was done with the single wires first described. Where the rope is to have a hemp center, as is often the case, an additional spool, carrying the hemp rope, is placed at the center of the disk and the rope carried up through the center of the head in such a manner that the metal strands, or wires, from the peripheral spools are twisted together around it. By replacing the hemp rope on the center spool with a wire and the wire on the peripheral spools with braid, it will be seen that the final product will be a wire wrapped with braid, such as is used for electric lamps. It will be quite plain to the engineer now how by suitable modifications and multiplications of the spools and their arrangement, and by alterations in the speed of twisting, almost any arrangement of the wire, strands and braiding may be produced in the final rope or cable.



Forged Angle Cross Frame for Japanese Plate Girder Bridges.
Pencoyd Iron Works, Philadelphia, Pa.

In making the more elaborately protected or armored cables the processes are not so simple. For instance, the ordinary lead-covered transmission cable is first wound with paper, next with hemp, next passed through a tank containing some mixture of asphaltum, and finally through the lead furnace. As is well known, the manufacture of lead pipe is by forcing it hot through the annulus formed by a cylinder with a fixed mandril inside. Lead-covered cable is made in much the same manner, the cable taking the place of the mandril, but moving continuously with the completion of the lead pipe, instead of remaining stationary. From the lead furnace the cable passes to the spools, or reels, upon which it is wound for shipment.

The various processes mentioned are carried on in separate buildings, and still other buildings are provided for vegetable rope manufacture, wire cloth making, etc. Suitable machine and blacksmith shops, in which the company's repair work is done, a testing laboratory, and various other buildings are also comprised in the plant.

Pencoyd Bridge Works, Philadelphia, Pa.—A visit to these works found every shop very busy on the steel work for the new 820-ft. arch at Niagara Falls, a large order of plate girder, narrow gage railway bridges for Japan, and a number of smaller contracts. In the Japanese plate girder work a hydraulic press for forging the cross frames was noticed for its rapid and perfect operation. The construction of these cross frames is indicated in the accompanying sketch. The hydraulic press forms the angle around a U-shaped die at one stroke, after which four angles are riveted together as shown, to form the cross frame. The angles are, of course, bent hot. This machine is, however, but one example of the many tools fitted to do special classes of work outside of the ordinary rivet and forge shop work with which this plant is equipped. In a future issue of Engineering News it is expected to publish a full description of these works, and further mention of their equipment will be left until then.

In a conversation with Mr. C. C. Schneider, Chief Engineer of the Structural Department, the rather interesting information was obtained that it was the intention to induce an artificial strain in the ribs of the new 820-ft. arch at Niagara Falls, for which this company has the contract. The general method of erecting this arch was described in Engineering News of Feb. 10, and from this description it will be seen that the anchor rods are so adjusted as to hold the adjacent ends of opposite halves of an arch rib at a higher elevation than they will assume when the connection is made and the anchor rods removed. At the time of making the connection, therefore, the anchor rods are lengthened to lower the ends of the two half arches so that they will meet. In this lowering process the bottom chords of the arch ribs will meet first. These chords are connected by a pin which will be driven as soon as they meet, and the arch is then practically a three-hinged arch. With this connection even after the top chords meet and are riveted, it is difficult to say just what form the stresses will take in the final position, so it is proposed by means of hydraulic jacks to induce artificial stresses of the exact nature and intensity which were assumed in calculating and designing the arch and then to insert shims to preserve these stresses after the jacks are removed. In this manner it is expected that the completed arch will have very closely the strains which it should have theoretically.

A COMBINED ELECTRIC-POWER SHOVEL AND AMALGAMATOR FOR PLACER MINING.

The accompanying half-tone cut illustrates a remarkable apparatus recently built in Colorado for working low grade placer mines. It is especially suitable for locations where there is a deficient supply of water, or difficulty in disposing of the hydraulic tailings. It consists of a massive power shovel or dredge, mounted on a turntable, a revolving screen, a pair of amalgamating tanks and an endless belt carrier for tailings, all carried in a steel railway car. The weight of the entire apparatus is about 90 tons. The whole machine is movable by power either forward and backward, sideways or up and down, so that it can be worked slowly over the most irregular surfaces, scooping up the gold-bearing earth as it goes along, extracting from it the valuable deposits and throwing away the tailings behind it.

FIG. 1.—VIEW OF THE BENNETT AMALGAMATOR AT WORK.

The car body, 40 ft. long and 12 ft. wide, is built up of 20-in. I-beams. The car is supported on two trucks with 36-in. wheels. These trucks consist in part of narrow frames of 20-in. steel I-beams, 20 ft. long, running at right angles to the fore and aft line of the main car body. In the ends of these long transverse truck frames are wheels on which the whole car can be moved sideways. Framed to these transverse beams are also regular four-wheel trucks, and if the weight of the car is borne on them, the car can be rolled forward and backward. Powerful jack screws are provided under each of the four corners of the main frame to level up the latter, no matter what the grade or side slope of the track may be. These jacks are operated either by hand or by a small motor. At the extreme ends of the transverse girders are mounted lifting jacks by which the whole car can be raised from all its wheels and rigidly supported when subjected to the strains of shoveling and digging. By means of these also the car can be lifted up from the longitudinal tracks and transverse tracks placed under the appropriate wheels, or vice versa, whenever it is desired to change the direction of its motion. In this way the heavy car can be moved with minimum labor over the most irregular ground and obstructions, and as it is arranged to dig 8 ft. below its track level, it can excavate for itself a pit into which it can be lowered and from which it can be raised. The longitudinal tracks are 8-ft. gage, and the transverse tracks 19-ft. gage.

The boom carrying the main dipper is mounted with a cab on the turntable revolving about a short stout mast. The main boom is double, the handle of the dipper running between the two steel I-beams of the boom, the lower ends of which are hinged to heavy steel I-beams on the turntable floor. The upper end of the boom is firmly held to a collar at the top of the mast by means of a pair of heavy steel cables, the inclination of the boom being always the same.

The dipper is raised and lowered by a flat crucible steel hoisting cable, 6 ins. wide. This passes over a sheave at the outer end of the boom and runs down to a drum mounted concentrically with the main hinged joint of the boom and turntable, this drum being driven through double reduction spur gear by a 25-HP. electric motor. The drum is small, giving great leverage to the driving train

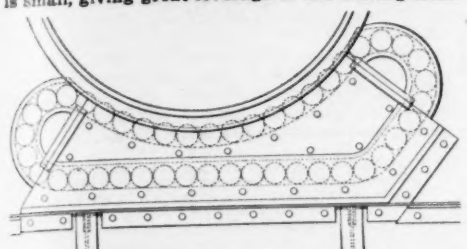


Fig. 2.—Ball Bearing Support of Revolving Screen.

at the start when the dipper is in the ground, the flat rope winding on to the drum and increasing its effective diameter, thereby diminishing the speed reduction between the motor and the dipper as the latter rises.

In operation the turntable is swung to a suitable point for scooping up a dipperful of gravel. The dipper is lowered until its handle is about in a vertical line when the bottom closes and latches automatically; the dipper is then run down in the gravel and is pulled up and forward by the hoisting cable, thus scooping up a load of earth. The turntable is then swung until the dipper hangs over the hopper of the amalgamator, and the charge falls into the hopper.

From the hopper the gravel passes into a revolving horizontal cylinder, which has two concentric grates or screens, the outer one 9 ft. and the inner one 7 ft. 4 ins. in diameter. The inner screen is provided on its inner surface with a double Archimedean screw, made of ¼-in. steel plates, each thread of the screw ending in a discharge bucket at the discharge end of the cylinder. The cylinder is rotated on ball bearings, the method of supporting it at each end being shown in the cut, Fig. 2.

The discharge buckets slide the drained stones and gravel first into a conical frustum at the discharge end of the cylinder, which delivers them without shock to the carrier. The cylinder containing the screens is submerged about 30 ins. in the amalgamating tank, which is always kept full of water.

The amalgamating tank is a trough of W-shaped section, the two valleys and the ends being lined with silver-plated copper amalgamating plates, so corrugated as to form them into a series of longitudinal pockets, one above the other, from the top to the bottom of the tank, each of which pockets carries a small body of mercury.

In the bottom of each valley of the tank there is placed a row of 20 ½-in. nozzles, which discharge streams of water upwards under about 50 lbs. pressure. These jets are inclined slightly from the vertical toward the rear of the tank, and slightly to right and left alternately. The positions of the jets cause the water, carrying the fine pay dirt, in the tank to form itself into four independent spiral currents, two in each valley, progressing towards the rear of the tank, and outwards, with each turn of the spiral, towards the corrugated pockets holding the mercury. These water spirals form the only route by which any particle of any substance, suspended in the water, can pass from the front to the end of the tank. A particle of sand, enclosing a finer particle of gold, entering the front end of the tank, would be caught in the ascending current near the first jet, and would then descend along the side of the valley passing over one corrugation after the other, the mercury at the same time draining from one pocket to another. The friction of the particles against each other and against the sides of the tank would expose the bright clean gold, and the mercury, being kept in gentle circulation, exposes constantly clean surfaces. The particle, if it remained coated so as to protect it from the amalgamating action of the mercury, by passing around 20 turns of the spiral and meeting 20 shelves containing mercury on each turn, would thus be brought in contact with the mercury 400 times before it could escape from the tank. But as soon as the coating of sand or clay is washed off so as to expose the bright gold, the mercury at once seizes it. The amalgamator contains in the bottom an agitator for keeping the material stirred, and a wheel at the discharge end for removing the fine tailings.

It is claimed for this process that it is far superior to hydraulic sluicing, in that by the latter there is a great loss of float gold, or particles so fine that they float away in water. The amount of water needed in this process also is far less than that used in sluicing, and the tailings give no trouble, as the carrier simply deposits them on the ground, from which the gravel was originally shoveled.

The inventor of the apparatus is Mr. Erastus S. Bennett, of Denver, Colo., and it is being exploited by the Bennett Amalgamator Mfg. Co., 36th and Wazee Sts., Denver, and 30 Broad St., New York city. We are indebted to our contemporary, the "Electrical World," for the cuts used in illustrating this machine.

PROGRESS OF WORK ON THE BOSTON SOUTHERN TERMINAL STATION.

In our issue of Jan. 14, 1897, we described in detail the plans for the new railway terminal station in Boston which will be a substitute for four existing stations, so that when completed the city will have two large union stations instead of a number of stations for the several railways entering that city. The work on this new station is now progressing rapidly in nearly all departments. The total estimated cost is about $4,000,000, and 87.5% of that amount is already under contract. During the winter the expenditures in connection with this terminal have been about $150,000 per month, and, beginning with March, they will be nearly $250,000 per month. There are about 1,000 men at work on the ground. Mr. George B. Francis, M. Am. Soc. C. E., is the Resident Engineer.

Norcross Bros., of Worcester, Mass., have the contract for the erection of the headhouse, and are now at work on the third story. They have practically completed the entire foundations for the subways, trainshed, and all the buildings near the headhouse. A contract has also been placed with them for the construction of the remainder of the subway, extending about ¼-mile, from the headhouse, and for the foundations of the express building, and the foundations and superstructure for the power-house building. They have commenced this work also. The same firm has the contract for covering the entire trainshed roof, and furnishing ventilation, lighting, cornices, gutters, etc. A large amount of backfilling has been done around the foundations.

The Pennsylvania Steel Co., of Steelton, Pa., which has the contract for the erection of the trainshed and other steel work, has already placed most of the solid flooring and bridging over the track subway, and one corner of the trainshed is now erected. Two large traveling derricks will soon be completed. Nearly all the steel required is upon the ground, and the progress of the steel erection for the shed proper should be very large during the next few months. Work will soon be begun in laying the roof boarding at some points.

A contract for the steel rails has been let to the Lackawanna Iron & Steel Co., of Scranton, Pa., and one for the frogs and switches to the Ramapo Iron Works, of Hillburn, N. Y. The Union Switch & Signal Co., of Swissvale, Pa., is building the interlocking plant at its shops, but has not yet placed any material upon the ground. A very large amount of sewer work has been completed by the city to free the site of the work from old sewers, and the city sea-wall along the Dorchester Ave., or Fort Point Channel side of the station is nearly completed. Westinghouse, Church, Kerr & Co., who have the contract for the power plant, have completed the boilers, and are now at work upon all other portions of their contract, but no plant has yet been placed in the power-house buildings. A contract has been made with the Pintsch Compressing Co., of New York, for the erection of a Pintsch gas plant.

The contract for a six-track drawbridge over Fort Point Channel upon one of the approaches to the station awaits the approval of the plans by the War Department. The type of bridge selected for this crossing is the "Scherzer" rolling-lift bridge, and the cantilever arms will extend the entire distance across the channel, and not join in the center. On account of the limited headway above the water, it is necessary that this should be a through bridge, instead of a deck bridge.

The Boston & Providence R. R., leased to the New York, New Haven & Hartford R. R., is at work upon the approaches from the neighborhood of the Park Square terminal station, which station is to be abandoned.

The waterproofing work, which was a serious problem, owing to the subway flooring being below the sea level, has proved entirely satisfactory. The cofferdam which surrounds this work and protects it from the inroads of sea water is about 700 ft. wide and 2,000 ft. long, made up in some places of a double, and in some places a single line of hard pine sheathing 6 ins. thick and about 35 ft. long, driven into the clay bottom. From the beginning of pumping out, which was about May 1, 1897, up to March, 1898, there has not been the slightest trouble with flooding the work.

Something like 12,000 tons of steel have been delivered, and immense quantities of stone, cement, brick, and other construction material have been delivered and put in place.

ELECTRIC TRACTION IN PARIS is being seriously considered by the Compagnie Générale des Omnibus. The scheme suggested is to expend some $5,000,000 on electrically equipping 15 lines as the first step, the money to be raised by bonds maturing in 1910, at which time the company's contract with the city terminates. As a second proposition it will equip ten other lines, provided the city will pay the principal of another bond issue for $3,000,000 which will also terminate in 1910. Other conditions are offered by the company, such as establishing new lines, returning all profits beyond the payment of 7% dividends and the reduction of fares to about 4 cts. It is planned to adopt storage batteries, and already negotiations are under way with some of the electric light companies for the necessary current, which is given as about 4,000,000 K-W. hours annually.

ANOTHER POWER SCHEME FOR NIAGARA FALLS includes the excavation of a canal from the Niagara River to Lockport, a distance of 20 miles, where the power will be utilized for manufacturing purposes. Already the city of Lockport has contracted with the Ontario & Lockport Power Co. and the Lockport Water & Electric Co. for a supply of 15,000,000 gallons of water daily for ten years, at an annual cost of $50,000. The canal will, in all probability, start from about ten miles above the falls and strike across country to the Lockport gorge.

A TIDAL MOTOR PLANT, which is said to be working successfully, has been established at Potencia, Cal., 18 miles from Los Angeles, by the Wright Wave Motor Co., of Los Angeles. A wharf 26 ft. wide has been built out to a distance of 350 ft., at which point the swell usually begins to break, and three motor floats are placed at the outer end. The up and down motion of each of the floats is communicated to the piston of a long hydraulic cylinder which pumps water into a tank at high pressure. This water then drives a Pelton wheel, which drives a dynamo. During a test of 16 consecutive days in December last, when the weather varied from calm to stormy, and the number of waves per minute varied from 3 to 8, the floats developed 2.3 to 3.5 HP. each, measured at the water wheels. It has been estimated that properly constructed floats would develop 5 HP. each, and that an installation of 1,000 HP. including an electric transmission line to Los Angeles would cost $175 per HP. The probable annual cost of repairs and of insurance against destruction of the plant by storms are not stated.

THE PATENT BUSINESS OF THE UNITED STATES, in 1897, says Assistant Commissioner of Patents Greely, exceeded that of any other year. The applications numbered 45,661, and 23,729 patents were granted. The expenditures of the office were $1,222,843; but the receipts exceeded the expenditures by $252,798. From 1840 to

1850, the annual average of applications was 1,186; in the eight years, beginning in 1890, the annual average was 41,479. Since 1880, the wonderful development of electrical inventions, telephones, the bicycle industry, etc., has had much to do with this increase.

THE DEFINITE PLANS FOR THE MAIN BUILDings of the Paris Exposition of 1900 have been settled upon. The entire Esplanade des Invalides will be covered by a great structure with two stories, with the central passageway on the line of the axis of the bridge of Alexander III. On the right bank of the Seine, the Avenue Nicholas II. will extend on the line of the bridge to the Champs Elysees, and this avenue is flanked on one side by the Great Palace of Fine Arts, and on the other by the Small Palace. At the Champs de Mars, a great building with two parallel wings covers very much the same site as the old buildings of 1889; but these will also be provided with wide galleries, to obtain more space. The contracts for these structures will probably be let on July 1, 1898, and they are to be finished by March 1, 1899. Mild steel and iron will be used in their construction.

THE INTERNATIONAL CORRESPONDENCE SCHOOL, of Scranton, Pa., has had built for it, by the Jackson & Sharp Co., a handsome railway car, designed to give distant points a practical demonstration of the methods of instruction pursued by the schools. The car is 50 ft. long, and is provided with a reception room, fitted bookcases, tables, etc., sleeping berths for eight persons, a storage room, and a saloon in the extreme end of the car. The President of the Schools and seven assistants will go out on the first trip, and the plan of work is to locate the car for a time in the immediate vicinity of large manufacturing establishments, and thus give those employed an opportunity to see for themselves just what the schools propose to do.

THE "ONE-PIECE" 8-IN. GATLING GUN, lately made for Dr. Richard J. Gatling by the Otis Steel Co., of Cleveland, O., is intended to be a wide departure from the present method of making guns of large caliber by the "built-up" process. While the details are withheld from the public, the general result of Dr. Gatling's late experiments seems to be the discovery of an alloy of steel with a tensile strength of 108,000 lbs. to the sq. in. This steel is cast into the intended form, and the steel surrounding the bore is then forged by a special process and thus made denser. After the completion of this process the gun is rifled, and is then ready for test or service. The advantages claimed are great comparative cheapness of construction for guns of all calibers, and a great saving in time of construction. This new gun will soon be tested at Sandy Hook.

A TOPOGRAPHICAL AND GEOLOGICAL SURVEY of Alaska is to be commenced by the U. S. Government under the Act of Congress of Jan. 28, 1898, appropriating $20,000 for this purpose. The officers assigned to the work are: George H. Eldridge and Arthur Keith, as geologists, and E. C. Bernard, Robert Muldron and W. S. Post as topographers. The expedition is to start from Seattle on May 1 on the U. S. gunboat "Wheeling."

OLD CABLES OF ALOE FIBER FOR FOOTWAYS have been tried by the French engineers, at Ceuta, Morocco, for the wearing surface of foot-bridges exposed to heavy traffic. Elm plank on oak stringers wore out rapidly, and finally, in 1894, old flat mine cables were substituted, made from the fiber of the aloe plant, and costing from $5 to $6.20 for 220 lbs. The thickness of these cables ranged from 1.37 to 1.96 ins., and their mean width was 8.65 ins. These flat cables were thoroughly tarred and nailed down to oak plank, across the axis of the bridge, and the ends were secured by light iron bands. These footways are found to be very elastic, and lasting; they are not slippery and the weight is only about 92 lbs. to the square yard. They are somewhat expensive, as the finished cost, including the cables, tar, nails, bands and labor, was about $3.76 per sq. yd. Up to the present time they show no trace of wear, though the daily passenger traffic passing over them varies from 600 to 2,000 persons.

THE GARBAGE QUESTION AT CHICAGO is still very far from a settlement, and in consequence the collection work is done carelessly and at long intervals, so that the alleys are in a disgraceful condition. Contracts for collection and disposal under improved systems were let some time ago, as noted in our columns, but these were blocked by the former contractors, who secured an injunction on the ground that the city had no power to award such contracts. The court has now granted a perpetual injunction, and the combination of the old contractors looked upon this as a victory, until they found that the Commissioner of Public Works had decided to have the work done by the city rather than under the inefficient methods of the former contract system. This is an experimental plan, which will be followed until the injunction suit is passed upon by the higher courts.

A 5-FT. RIVETED STEEL SEWER AT JERSEY CITY has been recommended by Mr. Chas. A. Van Keuren, Acting Chief Engineer of the Street and Water Board, and Mr. Frank Earle, Engineer of the Ravine Board Sewer Commission. The total length of the sewer would be about 1,850 ft., of which about 200 ft. has already been laid beneath railway tracks. The sewer would replace a two-ring brick sewer, 5 ft. in diameter, now in very bad condition. Steel pipe is recommended as being cheaper than a three-ring brick sewer, which the engineers think would be necessary to withstand the vibrations caused by the passage of railway trains over the sewer.

THE COMMERCE OF THE PORT OF NEW YORK, its decline and means for its revival, is to be investigated, according to the terms of a bill passed unanimously by the New York Assembly on March 22. This is a favorite measure of Governor Black and calls for a commission of five citizens of New York state, which is to thoroughly investigate the above subject and have power to engage the necessary assistants and to send for persons and papers useful in its investigations and to compel the attendance of residents of the state. The commissioners will receive their necessary expenses and disbursements incurred in the performance of this duty.

EXAMINATIONS FOR POSITIONS in the New York City service are to be held on the following dates: Assistant Engineer, April 5; Topographical Draftsman, April 7; Transitman, April 12; Leveler, April 15; Chainman and Rodman, April 19; Axeman, April 22. Candidates must be residents of the state of New York. Blank applications and further information can be obtained by addressing Lee Phillips, Secy., Criminal Court Building, New York city.

BOOK REVIEWS.

WHITTAKER'S MECHANICAL ENGINEERS POCKET-BOOK. By Philip R. Bjorling. Whittaker & Co., London and New York. Morocco, 6 × 4 ins.; pp. 337. $1.75.

The reason for the existence of this new "Pocket-Book" is not apparent in the book itself. It is simply a compilation of rules, tables and formulae, poorly selected, and in most cases given without authority, and in too brief a shape to be of much service to engineers. It is distinctly inferior to the other English pocket-books, "Molesworth" and "Clark," not to speak of the several American books of the class. It has an alphabetical index, but no table of contents. Turning over the pages of the book we find the order of the principal subjects and the approximate space given to each to be as follows: Water, Pumps, Valves, etc., 65 pages; Air, Wind and Wind Engines, 15 pages; Gas and Gas Engines, 4 pages; Steam and the Steam Engine, Condensers, Flywheels, Pumping, Winding and Hauling Engines, etc., 45 pages; Boilers, 18 pages; Pipes, 38 pages; Gearing, Rope Driving, Belts, Pulleys, Shafting, 19 pages; Beams, Joists, 5 pages; Coefficient of Friction, 1 page; Gravity, Accelerated Motion, Centrifugal Force, Pendulum, 4 pages; Thermometer and Barometer, 5 pages; Mining Machinery, Elevators, Fans, Speeds of Tools, Bolts and Nuts, 36 pages; Measures and Weights, 24 pages; Mathematical Tables, 62 pages; Index, 14 pages. The type used is large for a book of the kind, being the size used in our editorial columns, and abundant space is given to the formulae and notations, so that the quantity of information the book contains is probably not one-half of that contained in "Molesworth." The quality of the information, moreover, is doubtful, to say the least. On page 1 we are told that a New York gallon of water equals 221.819 cubic inches. On p. 153 it is stated that dividing the number of degrees by 57 gives the horizontal length per unit of the vertical. Both of these statements will no doubt be new to our readers. On p. 132 a formula is given to find the efficiency of a boiler, and it is stated that "an allowance of 10% must be made for priming." Formulae are given for finding the "nominal" horsepower of both boilers and engines, without anything to suggest that the term "nominal HP." is practically obsolete.

THE PLANNING AND CONSTRUCTION OF HIGH OFFICE BUILDINGS.—By William H. Birkmire. New York: John Wiley & Sons. Cloth, 6 × 9½ ins.; pp. XXII. + 355; illustrated; $3.50.

This book forms a very satisfactory supplement to the author's previous work on "Skeleton Construction in Buildings." While the first work devoted itself largely to questions of design of columns, beams, wind bracing and details, the present work takes up the more general questions of arranging the columns, partitions, elevators, toilets, etc., to secure the best light and to make the offices as desirable as possible from the point of view of the renter. It is still more valuable, however, for the large amount of space devoted to the discussion of the mechanical engineering features of the modern tall building, a subject concerning which engineers in the past have been able to find very little convenient information. Under this head the author describes and discusses modern practice in boilers, engines, dynamos, elevator mechanism, electric wiring, signals, safety devices, etc., etc. The question of heating is very fully treated. Another chapter which will be found especially useful is that on "Plumbing and Drainage." Such miscellaneous items as details of boiler room practice, elevator fittings, stairways, doors, shutters, etc., are treated in still another chapter.

In chapters on "Foundations," "Columns" and "Exterior Walls" the author discusses in a general form the tendency of practice in different cities, and describes the various methods of construction which have received the approval of extensive use. One of the longest chapters in the book is that on fireproofing. Nearly all of the modern fireproof floor systems are described, with tables of weights, the results for tests both for strength and resistance to fire and water, and various useful hints regarding construction and erection. A very full description of the Pittsburg, Pa., fire and the lessons to be drawn from it conclude the chapter. The book is fully illustrated with views of prominent tall buildings, details of floors, columns, foundations, etc., and a number of examples of ornamental terra cotta work and of grill work, doors and elevator cages. The publisher's work is generally good. The omission of an index is a fault which should be remedied in future editions.

DIE BERLINER ELEKTRIZITATS WERKE BIS ENDE 1896.—By Gustav Kemmann, Kaiserlichem Regierungsstrath. Berlin, Germany; Julius Springer; 1897. Linen; 12½ × 9¾ ins.; pp. 270, also 8 folded plates; fully illustrated. Price, 20 marks.

As stated in the title this is a description of the electric lighting installations of the city of Berlin, Germany, designed and constructed by Geplant und Erbaut, of the Allegemeinen Elektrizitäts-Gesellschaft, up to and including 1896. The material has been compiled by Gustav Kemmann from reports, drawings and other data, obtained from the company.

In the first chapter the use of electricity is briefly treated and the growth of the five central stations comprising the Berliner Elektrizitat Werke is traced. Descriptions of these plants are given with drawings and colored plates to show their location and the portion of the city supplied by each. A table is also given covering the period from 1885 to 1896, in which the number and kind of engines and boilers, the speed, output and voltage of dynamos, and the year of installation of the machinery are given for the plants mentioned.

Chapter II. takes up the transformation of energy from coal, to engine, to generator. Diagrams, drawings, and folded plates showing the different types of engines and their general construction, the forms of valves used and the operation of governors, condensers and barring-engines are given. This chapter includes descriptions and illustrations of the various types of boilers, feed pumps, coal-handling devices, valves, water intakes and other special apparatus connected with steam generation, such as separators, steam traps, etc. The piping systems of the five stations including steam and exhaust mains, feed and condensing water pipes, are printed in colors, together with diagrams and details. In considering the generators, diagramatic illustrations of the machine used are given, together with plans of winding and detailed views of construction, such as manner of mounting rocker wheel, brush pins, brushes, etc. The transformers employed in connection with the alternating work are also illustrated in detail.

In the third chapter, the various methods of transmission and distribution are considered, and numerous drawings and colored plates accompany the description. Splices, crossovers, manholes, cables, subways and many other points connected with feeders, branch circuits and house-connections are carefully considered. The switchboards employed in the stations are treated in detail, and under this head considerable space is given up to drawings illustrating the construction of switches for current control or for throwing in instruments. Large colored folded plates are used to show the connections about the switchboards of the different stations for direct, storage, alternating or three-phase work.

Efficiencies and station loads are considered in Chapter IV., and in connection with this subject a number of load curves and tables are given, indicating the ways in which current is used and the amount so used. A small section of this chapter is also devoted to the tariff rates or rate of charging for current. The volume concludes with reprints of the agreements between the municipality of Berlin and the stockholders of the Berliner Elektrizitats Werke relative to the sections to be lighted and the rates to be charged in each case.

Distributed throughout the book are 8 full-page photogravures representing interior views of the engine or boiler rooms of the plants described, which are remarkably fine specimens of the printer's art.

From cover to cover the book bears evidence of a desire on the part of both the compiler and publisher to present a model work, and for completeness in detail and excellence of both descriptions, plates and printing, little is left to be desired.